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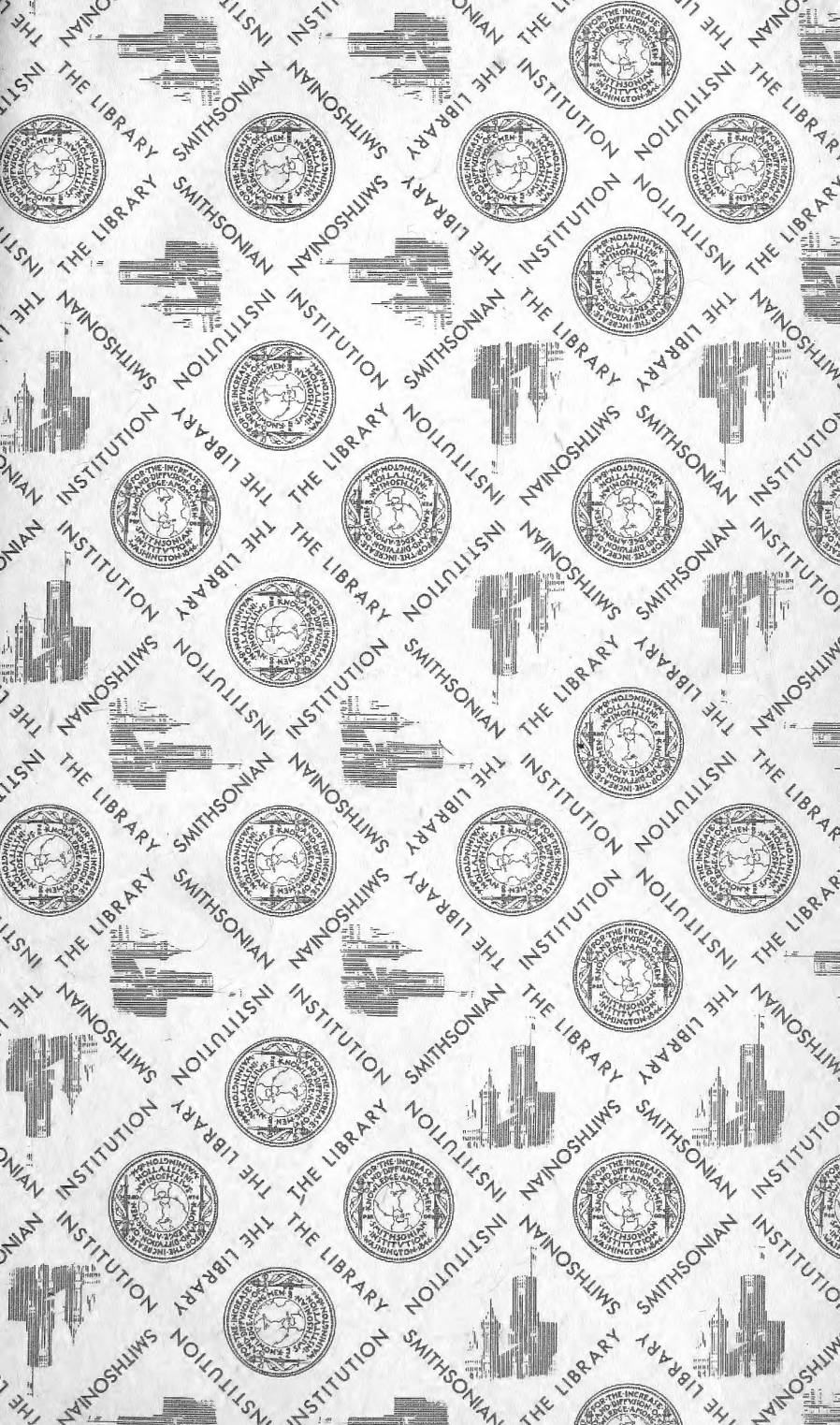
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PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY  
OF LONDON.

NOVEMBER 1826 to JUNE 1833.

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VOL. I.

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PROCEEDINGS  
OF  
THE GEOLOGICAL SOCIETY OF LONDON.

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1826—1827.

No. 1.

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THE Council of the Geological Society, being desirous of communicating to the Fellows as promptly as may be, an account of the Proceedings of the Society, during the intervals which must necessarily elapse between the appearance of the several Parts of the Transactions, has made arrangements for distributing, to the Fellows who reside in London and its vicinity, the abstracts of the papers read at the ordinary meetings, with such official documents as it may be thought expedient to publish;—which if preserved, will furnish a connected history of the Society.—Such of the non-resident Fellows as may be desirous of obtaining copies, may have them sent according to any address in town, notified by letter to the Secretaries.

The present Number contains an account of the Proceedings of the Geological Society, from the commencement of the Session in November last, to the annual meeting on the 16th of February, inclusive; and the Numbers will in future be continued, from time to time, according to the space occupied by the abstracts of the papers.

The Council has the satisfaction to inform the Fellows, that the Second Part of Volume II. of the second series of the Transactions, which has been for some time in the press, will be ready for publication in a few weeks.

*9th April 1827.*

PROCEEDINGS DURING THE SESSION OF 1826—1827.

Nov. 3.—Colonel Charles Silvertop, of Minster Acres, Northumberland, was elected a Fellow of this Society.

A paper was read entitled “Additional remarks on the nature and character of the limestone and slate principally composing the rocks and hills round Plymouth,” by the Rev. Richard Hennah, F.G.S.

The author refers to a former paper on this subject, in which he confined his field of observation to the narrow tract between the Plym and the Tamar;—he now extends its limits to Mount Batten and Statten Heights, in a southerly direction. In this tract which

forms the east side of Plymouth Sound, as well as the western side from Mount Edgcombe to Pudding Point, *animal remains* are imbedded in the slate. On the eastern side the superior beds are occasionally of an ochreous clay-slate containing thin veins of iron with trochites and stems of encrinites: these are associated with some peculiar fossil remains, resembling the head of some plant or animal. The lower beds consist of compact white or light gray slate inclosing remains like those found in the limestone and slate. An iron-stone bed occurs here which is used for pavements, and fragments of the same animal relics are discoverable in it: a great fissure in the cliff develops fossils of a new character, the nature of which has not been determined.

From the above facts the author infers, that the slate which is prolonged beyond the Plymouth limestone, even as far southward as Whitesand Bay, is not primitive: but he remarks that he has never perceived animal remains in the slate north of that limestone.

Extracts were read from letters from Captain Franklin, R.N. and Dr. Richardson, to Dr. Fitton, V.P.G.S. dated 5th of November, 1825, at Fort Franklin, on the Great Bear Lake, North America. Lat.  $65^{\circ} 12' N.$ ; long.  $123^{\circ} 5' W.$

Capt. Franklin states, that the expedition under his command had been so much favoured by the season of 1825, as to have accomplished some objects which he scarcely hoped to have attained within that time. Of these the most important were his having reached the sea in latitude  $69^{\circ} 29'$ , and longitude  $135^{\circ} 40'$ ; and having been enabled to see the direction of the coast, both east and west from the mouth of the Mackenzie River:—and while he was thus engaged on the Mackenzie, Dr. Richardson went round the northern shore of the Great Bear Lake, for the purpose of becoming acquainted with that part of it to which his course is to be directed in returning from the mouth of the Copper Mine River.—Capt. Franklin gives a general account of the structure of the tract on the course of the Mackenzie, through which he had passed; and Dr. Richardson describes the principal physical and geological features of the country traversed by the expedition,—the total distance being about 5100 miles.—The party, at the date of the letters, were established in their winter quarters.

Nov. 17.—A notice was read “On some beds associated with the magnesian limestone, and on some fossil fish found in them,” by the Rev. Adam Sedgwick, Woodwardian Professor, F.G.S.

This notice professes to be an abstract of a longer paper hereafter to be presented to the Society. (1.) It first describes a deposit which extends through Yorkshire and Durham, and separates the magnesian limestone from the coal measures. This is principally composed of sand and sandstone: but in one or two instances red marl and gypsum have been found associated with it. Its general character in Yorkshire is intermediate between the gritstone of the carboniferous order, and the harder beds of the new-red-sandstone. In the county of Durham it is said to appear in the form of a yellow incoherent sand of very variable thickness, which throws very



great difficulties in the way of all mining operations within the limits of the magnesian limestone. On a great scale it is considered as unconformable to the coal strata, and nearly co-extensive with the magnesian limestone; on which account it is classed with the latter formation. (2.) Next described is a deposit consisting in some places of shell-limestone, alternating with variously coloured marl,—and in other places of thin-bedded, nearly compact limestone alternating with bituminous marls. In the county of Durham this deposit is associated with an extensive formation of marl-slate. In this marl-slate many specimens of fish have been discovered; some of which appear to be identical in species with the fish in the marl-slate of Thuringia. In the same deposit have also been found many vegetable impressions. (3.) The great deposit of yellow magnesian limestone is briefly noticed; and it is stated not uncommonly to exhibit traces of the muriates of lime and magnesia, a fact which is supposed to connect it with the new-red-sandstone. (4.) The deposit of red marl and gypsum imbedded in the formation of the magnesian limestone is briefly described. (5.) Lastly is noticed the deposit of thin-bedded limestone which surmounts the gypsum, and in which magnesia is not so uniformly diffused as in the inferior member of the formation. Traces of this deposit are said to have been discovered in the county of Durham. And in Yorkshire beds of galena have been found subordinate to it, and worked with advantage. (6.) Over all these deposits comes the great formation of red marl and new-red-sandstone, which appears to be so intimately interlaced with the preceding subdivisions of the magnesian limestone, that the two formations cannot in any natural classification be separated from each other. The fossils found in various parts of the magnesian limestone are noticed, and are supposed to form a suite which more nearly resembles that of the carboniferous limestone than has generally been imagined.

A paper was read entitled “Observations on the bones of hyænas and other animals in the cavern of Lunel near Montpellier, and in the adjacent strata of marine formation,” by the Rev. W. Buckland, D.D. Professor of Mineralogy and Geology in the University of Oxford.

In a journey through France in the month of March 1826, the author visited the cave of Lunel near Montpellier, (to which his attention had been drawn by the description of M. Marcel de Serres,) for the purpose of instituting a comparison between it and the caves in England previously described by himself; and the result has established nearly a perfect identity in the animal and mineral contents of the caverns, as well as in the history of their introduction.

The cave of Lunel is situated in compact *calcaire grossier*, with subordinate beds of globular calcareous concretions; the whole of the rock having something of an oolitic structure. In working a free-stone quarry of this *calcaire grossier*, the side of the present cavern was accidentally laid open; and considerable excavations have since been made in it, at the expense of the French Government, for the purpose of extracting its animal remains that lie bu-

ried in mud and gravel, and of searching for the aperture through which all these extraneous substances have been introduced. These operations have exposed a long rectilinear vault of nearly 100 yards in length and of from ten to twelve feet in width and height. The floor is covered with a thick bed of diluvial mud and pebbles, occasionally reaching almost to the roof, and composed at one extremity chiefly of mud, whilst at the other end, pebbles predominate.

In another quarry of *calcaire grossier* a few miles distant, some vertical fissures are filled with similar materials to those within the cavern, and containing occasionally a few bones, sometimes cemented by calcareous infiltrations into a breccia like that of Gibraltar, Cette, and Nice. These materials are similar in substance to, and are uninterruptedly connected with, a superficial bed of diluvium that covers the surface of these quarries, and are identical with the general mass of diluvial detritus of the neighbourhood.

Stalactite and stalagmite are of rare occurrence in the cavern of Lunel; hence neither its bones nor earthy contents are cemented into a breccia.

On examining the bones collected in the cavern by M. Marcel de Serres and his associate M. Cristol, Dr. Buckland found many of them to bear the marks of gnawing by the teeth of ossivorous animals; he also discovered in the cave an extraordinary abundance of balls of album græcum in the highest state of preservation. Both these circumstances, so important to establish the fact of the cave of Lunel having been inhabited, like that of Kirkdale, as a den of hyænas, had been overlooked by the gentlemen above mentioned. The more scanty occurrence of stalactite, and the greater supply of album græcum in this cavern than in those of England, (see *Reliquiæ Diluvianæ*, vol. i.) are referred to one and the same cause, viz. the introduction of less rain water by infiltration into this cave, than into that of Kirkdale:—in the latter case a large proportion of the fecal balls of the hyænas appear to have been trod upon and crushed at the bottom of a wet and narrow cave, whilst at Lunel they have been preserved in consequence of the greater size and dryness of the chamber in which they were deposited.

M. Marcel de Serres has published a list of the animal remains contained in this cavern, which differ but little from those of Kirkdale: the most remarkable addition is that of the Beaver and the Badger, together with the smaller striped, or Abyssinian, Hyæna. For these discoveries we are indebted to the exertions of M. Cristol, a young naturalist of Montpellier, whose observations on the geology of that district the author found to be in perfect accordance with his own.

With respect to the bones of Camels said to have been discovered in this cavern, Dr. Buckland found on comparing rigidly the only bone which was supposed to be of that animal with the proportions given in Cuvier, that it certainly does not belong to the Camel. In some few parts of the diluvial mud there occur the bones of Rabbits and Rats; and M. Cristol has also discovered the leg of a Domestic Cock. All these Dr. B. found on examination to be of recent origin (not adhering to the tongue when dry, as do the antediluvian bones).

The Rats and Rabbits are supposed to have entered the cave spontaneously, and died in the holes which they had burrowed in the soft diluvial mud, and the Cock's bone to have been introduced by a Fox through a small hole in the side of the cavern, which had been long known as a retreat of Foxes, in the bottom of an ancient quarry.

Land shells, similar to those which hybernate in the soil, or in fissures of the neighbouring rocks, are also found in the mud that filled the cave. The author considers that these may either be the shells of animals that in modern times have entered some small crevices in the side of the cavern to hybernate there, and have buried themselves in the mud; or that they entered in more ancient times, and died whilst the cave was inhabited by hyænas, and lay mixed with the bones before the introduction of the mud and pebbles;—or that they were washed in by the same diluvial water which imported the diluvial detritus in which they are now imbedded.

Dr. Buckland draws a strong line of distinction between the mud and gravel of the caves and fissures, which he considers to be part of the general diluvium so widely spread over the adjacent country, and the local freshwater formations occurring also in the same neighbourhood of Montpellier; and which differ as decidedly from them, and bear to them the same relation as the gravel on the summit of Headen Hill in the Isle of Wight, bears to the strata of freshwater limestone that lie beneath it.

The author next proceeds to consider the epoch of the deposition of the remains of quadrupeds that have been found in some extensive quarries of stone and sand in the Fauxbourg St. Dominique at Montpellier, imbedded in a very recent marine formation which has been described by M. Marcel de Serres, in the 4th volume of the Linnean Transactions of Paris.

In the central beds of this deposit, the remains of the Elephant, Rhinoceros, Hippopotamus, Mastodon, Ox and of the Stag, are found intermingled with those of Cetacea, (the Dugong, or Lamantin); they are more or less rolled, and are occasionally covered with marine shells. Beds of oysters also (the *Ostrea crassissima* of Lamarck) and barnacles, occur in horizontal and nearly parallel strata amid the marine sand, and show this deposition to have taken place gradually and at successive though perhaps short intervals, rather than to have resulted from a sudden marine irruption. The period of this deposition is supposed by the author to have been that which immediately preceded, and was terminated by the last grand aqueous revolution which formed the diluvium.

To a similar and contemporaneous period with this upper marine formation of Montpellier, he refers the bones of the Elephant, Rhinoceros, &c. with marine shells, (oysters and barnacles,) adhering to them, that have been found in certain parts of the Sub-apennine hills; and also the bones of similar quadrupeds and shells that occur in the Crag of Norfolk and Suffolk.

To the same period also he assigns the bones of the osseous breccia of Gibraltar, Cette, and other fissures and caves along the north coast of the Mediterranean; and the accumulation of the remains

of bears, hyænas, &c. in the caves of Germany, England and France. He attributes the same date also to the bones of similar animals that are found buried in the sediments of the antediluvian fresh-water lake of the Upper Val d'Arno.

Dec. 1.—Henry Peile, Esq., of Hyde Park Place, West; and Henry Witham, Esq., of Lartington Hall, Yorkshire, were elected Fellows of the Society.

An extract of a letter from B. de Basterot, Esq. to Dr. Fitton, V.P.G.S. was read.

The author gives a short account of the succession of the strata in the vicinity of Folkstone, about which there had existed some uncertainty; from whence it appears that the Folkstone marl (or Gault) is separated from the lowest beds of the chalk by a stratum of green-sand, and is itself succeeded by sand and stone also abounding in green particles. The order being as follows: 1st, white chalk; 2nd, gray chalk; 3rd, (a.) sand containing green particles, and indistinct organic remains. (b.) marl of a dirty white colour mixed with the sand, and containing compact nodules; 4th, the blue marl of Folkstone (Gault) with Hamites, Inocerami, Ammonites and a small Belemnite; 5th, thick beds of sand and sandstone full of green particles, but void of organic remains.

The reading of a paper was commenced, entitled "Additional notes on part of the opposite coasts of France and England, including some account of the Lower Boulonnois, by W. H. Fitton, M.D. V.P.G.S."

Dec. 15.—Sir Henry Calvert, Baronet, was elected a Fellow of the Society.

The reading of Dr. Fitton's paper, begun at the last meeting, was concluded.—Since the reading of a former communication of the author, the correct identification of the beds beneath the chalk suggested by Mr. Lyell, and an examination of the strata in the vicinity of Weymouth, have enabled him to compare some portions of the country on the opposite sides of the English Channel more accurately than before was practicable: and he now, 1st, describes in detail the strata which succeed the chalk in the vicinity of Folkstone; and 2ndly, gives a general description of the Lower Boulonnois.



The following table exhibits the series of beds within the tracts just mentioned.

Names, chiefly derived from locality in England.	Places of Occurrence.	
	In England.	In the Lower Boulonnois.
<i>Chalk</i> .....	Cliffs from Dover to Folkstone-hill—Beachy-head to Brighton—I. of Wight—I. of Purbeck, Dorsetshire, &c.	Coast from Sangatte to Blanc-nez,—and thence on the boundary of the Lower Boulonnois, to Mont St. Frieux, &c. W. of Neufchatel.
<i>Merstham Stone</i> (Greensand — Fire-stone. — Upper-green-sand.— <i>Tufau</i> of the French.)	Merstham, Reygate, and Godstone Firestone-pits — Western Sussex (Malm Rock)—I. of Wight—Swanage Bay, I. of Purbeck, &c.	Coast between Blanc-nez and Wissant.
<i>Gault</i> ..... (Folkstone-marl. — <i>Diève</i> of the French.)	Copt-Point, N. of Folkstone.—Valley beneath the chalk in Kent, Surrey, and Sussex.	Coast on the N. of Wissant.—vicinity of Hardingen.—Lottinghen.—Vicinity of Samer.
<i>Shanklin Sands</i> (lower Green-sand.— <i>Tour-tia</i> of the French.)	Coast Folkstone to Hythe.—vicinity of Maidstone, Kent.—Western Sussex.—Shanklin and Blackgang-chines, I. of Wight.	Coast N. of Wissant:—vicinity of Wissant.—Wooded hills parallel to the chalk, from Desvres to Samer, &c. &c.
<i>Weald Clay</i> .....	Wealds of Kent and Sussex.—Cowleaze-chine, I. of Wight.—N. of Swanage Bay, I. of Purbeck.	} Not ascertained in the Boulonnois.
<i>Hastings Sands</i> ...	Hastings, Sussex.—S. coast of the I. of Wight—Swanage Bay.	
[ <i>Purbeck Stone</i> ?]	I. of Purbeck—Summit of the I. of Portland?	Qu. traces in the upper part of the cliffs from Gris-nez to Equihen.
[ <i>Portland Stone</i> ?]	Shotover Hill, and Garsington, Oxfordshire—Brill-hill, Bucks.	Upper part of the cliffs from Gris-nez to Equihen.—Mont-Lambert quarries.
<i>Kimmeridge, and Weymouth beds</i>	Coast near Weymouth, — Hedington-quarries, Oxfordshire.	Coast from Gris-nez to Equihen.—Mont-Lambert quarries.—Vicinity of Desvres.—of Samer, &c. &c.
<i>Pisolite and Coral-rag.</i>	Coast near Weymouth, — Hedington-quarries, &c., Oxfordshire.	Basinghen, Hautenbert, A-linctun;—Hesdin L'Abbé, &c.; Vicinity of Samer.
<i>Oxford Clay</i> .....	Coast near Weymouth. — vicinity of Oxford.	Vicinity of Wast—Houlfort.—Between Basinghen and Marquise.
<i>Bath-oolite</i> .....	Vicinity of Bath.	Vicinity of Marquise—Quarries at Leubringen — Ardentun—Rety, &c.
—(unconformable)—		
<i>Coal-formation.</i>		Vicinity of Hardingen, — Lochingen,—Cedur, &c.
<i>Mountain-Limestone.</i>	Derbyshire.—Devon.—Vicinity of Bristol.—Dublin.	Leulinghen. — Quarries at Ferques, Haut-banc, &c.

I. On the N.E. of Folkstone, the chalk is succeeded by the equivalent of the *Merstham Firestone*, (or green sand,) which is there however not more than fifteen or sixteen feet in thickness; and this is followed immediately by *Gault*. The *Shanklin Sands*, (or lower green sand,) which come next in succession, are composed of three groups, which may be recognized also in the interior of the country. The first and uppermost consists of sand, abounding in irregular concretions of limestone and chert, sometimes disposed in courses oblique to the general direction of the strata: and the top of this sand, in the vicinity of Folkstone and Hythe, forms an extensive plateau resembling that of the Blackdown range of hills in Devonshire.—The second group of this formation likewise consists chiefly of sand, but in some places so much mixed with clay, or with oxide of iron, as to retain water; and it is remarkable for the great variation of its colour and consistency,—from the state of loose bright yellow or ferruginous sand, to that of a dark greenish tough mass, like that of the cliffs of Shanklin and Black Gang-chines, which correspond to it in geological situation.—The third and lowest group of the Shanklin Sands abounds, near Folkstone, much more in stone; the concretionary beds being closer together and more nearly continuous. The fossils of this group, which are very numerous, agree with those of the corresponding beds in Sussex, the Isle of Wight, and Devonshire; and some of them are found also in the limestone of the Isle of Portland. The sections of the *Weald Clay*, and *Hastings Sands*, being imperfectly displayed on the coasts of Kent and Sussex, the author gives detailed lists of the beds at Cowleaze-chine, &c., on the south coast of the Isle of Wight, and on the shore of Swanage Bay in the Isle of Purbeck, where these formations are fully disclosed; referring for an account of the geological relations of those tracts, to a paper published by himself in the *Annals of Philosophy* for November 1824\*.

II. The Lower Boulonnois may be described as constituting a flattened dome of unequal curvature, surrounded on three sides by an amphitheatre of chalk, which has been removed by denudation from the whole of the interior; the lower strata having a very gentle inclination where they emerge from beneath the chalk, but rising from the sea at a much more considerable angle. From the chalk down to the *Shanklin* (or lower green) sands, the strata of the opposite coasts near Calais and Folkstone, precisely correspond; and the same beds may be traced beneath the chalk, almost without interruption, around the whole of the denudation; the *gault* especially, being very distinctly disclosed in the vicinity of Hardingham where it is succeeded by the Bath-oolite, and by the coal formation. The next succeeding beds of the English coast, *Weald-clay* and *Hastings sands*, (which it is remarkable, have not yet been found in the interior of England,) appear to be wanting also in the Boulonnois; or, if they do exist there, to occupy a very small space. But some traces of the lowest members of the group to which these two strata belong, and which is remarkable from its containing

\* New Series, vol. viii. p. 365, &c.

throughout the remains of freshwater shells, are visible on the summit of the cliffs between Gris-nez and Equihen: where a thin bed occurs of somewhat bituminous clay, abounding in silicified wood, the cavities of which are coated with minute crystals of quartz. This bed corresponds precisely to that which exists on the top of the Isle of Portland, bearing there the name of 'Dirt,' and abounding in similar wood; and on the French coast it is associated with beds of limestone, different from the stone beneath, and containing shells in great numbers, apparently of the genera *Cyclas* and *Ampullaria*. The next stratum of the Boulonnois is the same with that which occurs at Garsington and Shotover-Hill in Oxfordshire, and at Brill and other places in the vicinity of Aylesbury in Buckinghamshire,—and which has hitherto been regarded as the representative of the *Portland limestone*.—Respecting its geological relations, however, some doubts still remain to be cleared up; since, although several of the fossils are the same with those of the Isle of Portland, the aspect of some of the beds, differs a good deal from that of the Portland stone; and the characters agree in many respects with those of the lowest beds of the Shanklin-sands in the vicinity of Hythe. The formation in the Boulonnois consists, as in Oxfordshire, of calcareous concretions of great size, abounding in petrifications, and imbedded in yellowish somewhat ferruginous sand: and the appearance of the stratum, especially between Gris-nez and Audreselles, where the shore is covered with these enormous masses fallen from the sands above, is exceedingly striking and remarkable. To this formation a series of beds succeeds, the equivalent of the strata between the Portland limestone and the coral rag:—corresponding precisely to those of the shore near *Weymouth*, and consisting of alternations of sand, limestone and clay, in some instances bituminous and abounding in fossils.—These occupy the whole of the lower part of the cliffs from Gris-nez to Equihen, and are visible in several places in the interior. The *pisolite* and *coral rag* are not seen upon the coast, but come up at a short distance within it; and their outcrop is conspicuous at Basinghen, and along a line extending from that place, by Wierre and Hautenbert, to Alinctun. On the north of that line this formation is succeeded by a valley constituting a very remarkable feature of the country, and occupied by beds of clay containing fossils identical with those of the *Oxford clay*, and including, especially at the lower part, subordinate beds of sand and calcareous grit. These are followed on the north, near Marquise, by the equivalent of the *Bath-oolite*, (the Cornbrash and Forest-marble, which precede the oolitic beds near Bath, being indistinct or wanting):—and this formation seems to come in without any intervention, immediately after the gault or subjacent sand, on the north of the denudation; where it occupies the surface, in nearly horizontal strata placed unconformably over beds of the *coal formation*, or of *mountain limestone*.—The former of these is disclosed in a small space only, in the vicinity of Hardingen: and the author refers for an account of it to a Memoir now preparing for publication by M. Garnier of Arras.—The *mountain limestone*, which is the lowest formation of the Boulonnois, in some places comes in imme-

diately after the lower green sand, or the gault, without the intervention even of the oolite: and near Landrethun the distance from the chalk to the limestone beds is not more than a quarter of a mile. In some cases, when the incumbent mass of oolite is removed, the surface of the limestone beneath is found to be smooth, or slightly waved like the sands of the shore after the tide has retired; and the rock is pierced by tubular perforations evidently the work of marine animals; a proof that the surface must have been exposed to their activity for some time before the oolite was deposited. The beds of mountain limestone of the ordinary character, in some places alternate with dolomite, precisely resembling that which is found in the same geological situation near Dublin. And the fossils of this formation in the Boulonnois are the same with those of Derbyshire, Gloucestershire, and Dublin.

On comparing in a general view the strata of the opposite coasts, it will be seen that those of the Boulonnois do not occur upon the English shore, except in the vicinity of Weymouth: and if the line of elevated strata which extends from that part of the coast of Dorsetshire, through the Isle of Purbeck and the Isle of Wight, were continued to the eastward, it would reach the French coast near Gris-nez;—just at the place where the same beds arise, and where it is remarkable their position is likewise very highly inclined.

Jan. 5.—A notice was read, accompanying some specimens from the Hastings-Sand Formation, with a copy of a work on the fossils of Tilgate Forest; by G. Mantell, Esq. F.R., L. and G.S.,—in a letter to R. I. Murchison, Esq. Sec. G.S.

The author states that his principal object in the present volume, is to give a correct and extended view of that division of the Hastings Sands, distinguished by him in the strata of Tilgate Forest, the relations of which he illustrates by the section of a quarry at Pounceford, where the Ashburnham limestone with bivalves, &c. is seen overlying sandstone and calciferous grit (Tilgate stone).

A recapitulation of the animal and vegetable remains (in which the author particularly notices that gigantic Saurian the *Iguanodon*) shows the vast preponderance of land and freshwater exuviae in the Hastings strata over those of marine origin; a circumstance in strict accordance with what is now constantly occurring in all deltas and estuaries of great rivers.—A description is given in the concluding chapter of the work, of the probable condition of the country anterior to the epoch of this deposit.

The reading of a paper was commenced, entitled “On the coal-field of Brora, in Sutherlandshire, and some other stratified deposits of the North of Scotland;” by R. I. Murchison, Esq. Sec. G.S. F.R.S.

Jan. 19.—The Meeting intended for this evening was postponed in consequence of the decease of his Royal Highness the Duke of York.

Feb. 2.—Lord Ribblesdale, of Ribblesdale Park, Yorkshire, and



John Hoptown Forbes, Esq. of Ely Place, were elected Fellows of this Society.

The reading of a paper was concluded, "On the coal-field of Brora in Sutherlandshire, and some other stratified deposits in the north of Scotland;" by R. I. Murchison, Esq. Sec. G.S. F.R.S.

The Brora coal-field forms a part of the deposits, which on the S.E. coast of Sutherlandshire occupy a tract of about twenty miles in length, from Golspie to the Ord of Caithness; and three miles in its greatest breadth:—divided into the valleys of Brora, Loth, and Navidale, by the successive advance to the coast of portions of the adjoining mountain range which bounds them on the W. and N.W. The first of these valleys is flanked on the S.W. by hills of red-conglomerate; which pass inland on the N.E. of Loch Brora, and give place to an unstratified granitic rock that forms the remainder of the mountainous boundary.

With a view to the comparison of the strata at Brora with those of England, the author had previously examined the N.E. coast of Yorkshire, from Filey-Bridge to Whitby, comprising the coal-field of the Eastern Moorlands above the lias.

The highest beds at Brora consist of a white quartzose sandstone, partially overlaid by a fissile limestone, containing many fossils,—the greater number of which have been identified with those of the calcareous grit beneath the coral rag;—and along with these Mr. Sowerby has discovered several new species. The next beds, in a descending order, are obscured, in the interior, by the diluvium which is generally spread over the surface of these valleys, but are exposed on other places on the coast; and they consist of shale with the fossils of the Oxford clay, overlying a limestone resembling Cornbrash and Forest Marble, the latter associated with calciferous grit. To these succeed sandstone, and shale containing belemnites and ammonites, through which the shaft of the present coal-pit is sunk, to the depth of near 80 yards below the level of the river Brora. The principal bed of coal is 3 feet 5 inches in thickness, and the roof is a sandy calcareous mixture, of fossil shells and a compressed assemblage of leaves and stems of plants, passing into the coal itself. The fossils of this and the superior beds are identical for the greater part, with those which occur in the strata above the coal in the E. of Yorkshire: and of the whole number of species collected by the author, amounting nearly to fifty, two-thirds are well known fossils of the oolite;—the remainder belonging to new species represented in the last numbers of the Mineral Conchology. The plant of which the Brora coal appears to have been formed, is identical with one of the most characteristic vegetables of the Yorkshire coast, but differs essentially from any of the plants found in the coal measures beneath the new-red-sandstone:—It has been formed into a new genus by Mr. König, and is described by him in the present memoir, under the name of *Oncylogonatum*.

The author, therefore, considers the Brora coal, from its associated shells and plants, as the equivalent of that of the Eastern Moorlands of Yorkshire.

At Loth, Helmsdale, and Navidale, shale and sandstone overlie

calcareous strata resembling the Cornbrash and Forest marble, and these are in many cases dislocated where they are in contact with the granitic rock, and distorted where they approach it.

The base of the entire series above mentioned is seen at low water on the coast near the north and south Sutors of Cromarty, where the lias with some of its characteristic fossils is observable resting upon the sandstone of the red conglomerate,—the latter in contact with granitic rock.

On the N.W. coast of Scotland, several members of the oolitic series with their peculiar organic remains were recognized by the author in the isles of Skye, Pabba, Scalpa, Mull, &c.; where their occurrence was first noticed generally by Dr. MacCulloch.

A short sketch is given of the geognostic relations of the schists and sandstones of Caithness, which are probably referrible to the new-red-sandstone;—some of these beds resembling the copper slate of Thuringia, and its associates: whilst the fossil fish recently discovered at Banniskirk, though the species is new, appear to belong to the same family with those of Mansfelt, in Germany.

The paper concludes by adverting to the support given by the preceding facts to the great importance of zoological evidence in the identification of distant deposits:—since the existence in the N. of Scotland, of a large portion of the oolitic series of England, has been demonstrated from the agreement of organic remains, although the mineralogical characters of the beds containing these fossils are perfectly distinct at the extremes of the tract through which the strata are distributed.

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*Annual General Meeting of the Fellows, 16th February 1827.*

A Report from the Council was read, of which the following is an abstract.

Comparative Statement of the number of Fellows and Foreign Members, at the last and present Anniversaries.

Fellows.	17th Feb. 1826.	16th Feb. 1827.
Having compounded .....	41	42
Contributing .....	134	133
Non-resident .....	193	200
	<hr/>	<hr/>
	Total 368	375
Foreign Members .....	47	47

The Report of the Auditors exhibits the following Statement of the *Income and Expenditure of the Society during the last year.*

*Sources of Income.*

	£	s.	d.
Annual Contributions .....	434	14	0
Admission fees, from 7 resident Fellows, at 6 <i>l.</i> 6 <i>s.</i> .....	44	2	0
Ditto from 7 non-residents, at 10 <i>l.</i> 10 <i>s.</i> 7 <i>d.</i> .....	73	10	0
	<hr/>		
Rents receivable .....	140	0	0
Dividends on Stock .....	12	10	0
	£704	16	0
	<hr/>		

*Actual Receipts.*

	£	s.	d.
Balance, Dec. 31, 1825 :			
In Banker's hands .....	478	9	4
In the Collector's hands .....	25	4	0
Arrears of Contributions, for 1825 and former years .....	21	0	0
Annual contributions 1826 .....	393	15	0
Admission fees (1826 and preceding years) .....	96	12	0
Compositions .....	71	8	0
Rents and arrears of Rent received .....	217	10	0
Sale of Transactions .....	259	4	0
Interest on Stock .....	12	16	8
Contributions overpaid by 5 Members : (placed to their credit) .....	15	15	0
	<hr/>		
	£1591	14	0

*Expenses incurred.*

	£	s.	d.
House expenses .....	273	8	4
Taxes and Insurance .....	119	16	2
Repairs .....	16	14	2
	<hr/>		
Printing, Stationery, &c. ....	409	18	8
Salary to Mr. Webster .....	80	4	5
Collector's poundage .....	100	0	0
Rents payable .....	20	0	0
Miscellanies .....	180	0	0
	79	0	6
	£869	3	7
	<hr/>		

*Actual Payments.*

	£	s.	d.
Debts outstanding at the close of 1825 .....	118	5	10
General expenditure 1826 (House, Salaries, &c.) .....	544	2	10
Rents paid .....	180	0	0
On account of publication of Transactions, } vol. 1, Part 2 .....	254	8	1
Ditto ditto vol. 2, Part 1 .....	194	8	9
Investment in the Funds .....	178	10	0
Balances, at the end of 1826 :			
In the Banker's hands .....	48	15	0
In Mr. Webster's hands .....	41	13	6
In the Collector's hands .....	31	10	0
	<hr/>		
	121	18	6
	<hr/>		
	£1591	14	0

*Estimate of the Society's Property on the 31st December 1826, (exclusive of Lease, Furniture, Library and Collections.)*

<i>Property.</i>		<i>Due by the Society.</i>	
	£ s. d.		£ s. d.
Balances (Banker, &c.) .....	121 18 6	Bills unpaid .....	157 8 6
Arrears due to Society: .....	£ s. d.	Mr. Webster's cash account ..	38 1 3
Of Admission Fees .....	44 2 6	On account of Transactions ..	57 3 4
Of Annual Contributions .....	60 7 6		<u>252 13 1</u>
Dividends on Stock .....	104 10 0	Salaries due:	
Rents due to the Society .....	10 0 0	To Mr. Webster .....	50 0 0
		To the Collector .....	20 0 0
Stock in the Funds 3 per cents reduced .....	520 0 0		<u>70 0 0</u>
Estimated value of Transactions unsold .....	510 0 0	Contributions overpaid (and placed to credit of Fellows) .....	15 15 0
		Rents due by the Society .....	45 0 0
			<u>973 0 5</u>
	<u>£1356 8 6</u>	Balance in favour of the Society .....	973 0 5
			<u>£1356 8 6</u>

The Council has to report to the General Meeting that they have prepared a draft of the Bye-laws under the charter, which they propose to submit to the Society at an early period.

The Museum has received many valuable donations since the last Anniversary, of which the following are the most important.

*British*.—Fossil bones from Kent's hole near Torquay ; presented by Mrs. Cazalet.

Specimens of Crinoidea from Lancaster ; presented by Mr. Gilbertston.

Specimens of Rocks and of organic remains, to illustrate his memoir on certain stratified deposits in the North of Scotland ; presented by R. I. Murchison, Esq. Sec. G.S.

Specimens from Cader Idris N. Wales, in illustration of his memoir ; presented by A. Aikin, Esq., F.G.S.

Specimens chiefly of primitive rocks, from Sutherland N. Britain ; presented by Matthew Culley, Esq., F.G.S.

*Foreign*.—Organic remains from N. America ; presented by Lieut. Bayfield, and Henry Warburton, Esq. F.G.S.

Fossils from Volhynia, the Volga, and Jamaica ; presented by Sir A. Crichton, V.P.G.S.

Rocks and simple minerals from N. America : presented by Dr. Hossack.

By the plan adopted last year for the disposal of the duplicates, space has been obtained for the reception of several thousand new specimens ; and the Council hopes that the collection will be still further condensed and improved, in the course of the ensuing year.

The Library has been increased, by the donation of 45 volumes ; and among the maps received, the Council has particularly to mention those of the neighbourhood of the Rhine and Low Countries, accompanied by Sections ; presented by the authors Messrs. Oeynhaus and Dechen.

The first Part of a Second Volume of the Second Series of Transactions has been published, since the last Anniversary ; and another Part is now in the press.

*Papers read at the Meetings of the Society since the last Anniversary.*

On the strata of the Plastic clay formation exhibited in the cliffs between Christchurch Head, Hampshire, and Studland Bay, Dorsetshire ; by Charles Lyell, Esq., F.R.S.

On the Geology of the valley of St. Lawrence ; by Dr. Bigsby.

On the Geological position of some of the rocks of the N. E. of Ireland ; by Lieut. Portlock, R.E. F.G.S.

On the Freshwater strata of Hordwell, Beacon, and Barton Cliffs, Hants ; by Charles Lyell, Esq., F.G.S.

On the Geological structure of Cader Idris ; by Arthur Aikin, Esq. F.G.S.

On the nature and character of the limestone and slate composing principally the rocks and hills round Plymouth; by the Rev. Richard Hennah, F.G.S.

On some beds associated with the Magnesian limestone and on some Fossil fish found in them; by the Rev. Adam Sedgwick, Woodwardian Professor, University of Cambridge, F.G.S.

Observations on the bones of hyænas and other animals in the cavern of Lunel near Montpellier, and in the adjacent strata of marine formation; by the Rev. W. Buckland, D.D. &c.

Additional notes on part of the opposite coasts of France and England, including some account of the Lower Boulonnais; by William Henry Fitton, M.D. V.P.R.S.

On the Coal Field of Brora in Sutherlandshire N. B., and some other stratified deposits of the North of Scotland; by R. I. Murchison, Esq., Sec. G.S.

The Reports having been read—it was Resolved,

1. THAT these Reports be approved of, and that such parts of them as the Council shall think fit, be printed and distributed among the Fellows of the Society.
2. THAT the thanks of the Society be given to John Bostock, M.D. retiring from the office of President.
3. THAT the thanks of the Society be given to Sir Alexander Crichton, Charles Stokes, Esq., and William Henry Fitton, M.D. retiring from the office of Vice-presidents.

The Meeting then proceeded to the election of officers for the ensuing year, when the following list was delivered in by the scrutineers,—viz.:

*President*: William Henry Fitton, M.D. F.R.S.—*Vice-Presidents*: Arthur Aikin, Esq. F.L.S.; John Bostock, M.D. F.R.S.; Rev. W. D. Conybeare, F.R.S.; Rev. Adam Sedgwick, F.R.S. Woodwardian Professor, Cambridge.—*Secretaries*: W. J. Broderip, Esq. F.L.S.; R. I. Murchison, Esq. F.R.S.—*Foreign Secretary*: Henry Heuland, Esq.—*Treasurer*: John Taylor, Esq. F.R.S.—*Council*. Henry Thomas De la Beche, Esq. F.R. & L.S.; J. E. Bichenor, Esq. Sec. L.S.; Davies Gilbert, Esq. M.P. V.P.R.S.; George Bellas Greenough, Esq. F.R. & L.S.; John Frederick William Herschel, Esq. Sec. R.S.; Armand Levy, Esq.; Charles Lyell, Esq. F.R.S.; William Hasledine Pepys, Esq. F.R.S.; Rev. John Honeywood Randolph; Charles Stokes, Esq. F.R.S. & L.S.; J. F. Vandercom, Esq.; Henry Warburton, Esq. M.P. F.R.S.; Thomas Webster, Esq.; Thomas Young, Esq.

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No. 2.

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March 2.—Henry Blanshard, Esq. of Great Ormond Street, London; Richard Cowling Taylor, Esq. of Wilmington Square, London; and John Watson Pringle, Esq., Captain in the Royal Engineers,—were elected Fellows of the Society.

A paper was read, “On the volcanic district of Naples;” by G. Poulett Scrope, Esq. F.G.S. F.R.S.

In this paper the author purposes to confine himself to a general view of the volcanic formation of this district, and to such observations as have hitherto escaped notice, or on which he differs from other writers.

At one extremity of the tract in question lies the habitually eruptive volcano of Somma; at the other the once active vent of Ischia; the intermediate space is studded with hills, evidently thrown up by numerous eruptions, succeeding one another at distant intervals, and from separate though neighbouring orifices. These are arranged in one general band, which is remarkable from its parallelism to the elevated limestone range forming the opposite side of the Bay of Naples, and separating it from that of Salerno.

Somma is a very regular, volcanic mountain, created by the accumulation of repeated streams of basaltic lava and beds of ejected ashes, sand and scoria, round a central and habitual vent.

The author dissents from the theory of Von Buch, that such mountains were produced by the forcible elevation of horizontal beds round an aperture of eruption;—though he allows that beds originally inclined, may often suffer a certain degree of elevation, during the shocks occasioned by the forcible protrusion of lavas from below, into the fissures through which they are emitted.

The great crater of Somma is attributed to the explosions of the “paroxysmal eruption” of A. D. 79; and the whole cone of Vesuvius which occupies the centre of that crater, is stated to have been created by repeated, subsequent eruptions. This cone is similar in structure to that of Somma, as is seen in the walls of its actual crater, compared with those of the Atrio del Cavallo.

Ischia is a less regular, volcanic mountain; has produced no leucite, and none but trachytic, or rather, according to the author's nomenclature, gray-stone lavas,—a class intermediate between trachyte and basalt, and consisting of felspar and augite. The great mass of the island is composed of the conglomerates belonging to this class of lavas, forming an indurated tufa of a light green colour. There are traces of a vast central crater on the west of the Monte

Epomeo. Some of the lavas of Ischia are remarkably brecciated and zoned,—with varieties of grain, texture, and mineral composition.

The intermediate district between Somma and Ischia, properly called the Campi Phlegrei, including the islands of Procida and Nicida, exhibits the traces of between twenty and thirty crateriform basins, many of very large diameter, but in general much degraded, and sometimes almost obliterated, by the erosive action of the sea and of rains on the loose conglomerates of which they are partly composed, and by the ejections of later, neighbouring eruptions. Ten at least of these cones, with their included craters, are however very nearly entire; such are the Monte Nuovo, produced in the year 1538; Capo Mazza, a hill entirely composed of silky pumice and its detritus; the Monte Gauro, which incloses a deep circular crater a mile in diameter; Astroni, which is nearly equal to the last in size, and precisely similar in figure; the basins of the lakes Averno and Agnano; the island of Nicida; the southern extremity of the island of Procida; the Capo di Miseno; and the Solfatara of Pozzuoli.

The author disputes the existence of any large vaulted cavity under the floor of the last-mentioned crater; and attributes the reverberation produced when it is struck sharply, to the cellular nature of the beds of indurated clay which form this floor, and have been deposited from the washings of the surrounding slopes, and hardened by the influence of heat and moisture.

The author accounts for the production of two varieties of Pisolite, which occur in the tufa and decomposed lava of the Solfatara. This hill is recorded to have been in eruption in A. D. 1180; and the present crater may have been formed at that late epoch. The hill which supports the Camaldoli, 1643 feet above the sea, is a remarkable mass of indurated tufa; from beneath which, on the N. E. side, crops out a bed of gray-stone, in which a singular, concretionary separation has taken place, of the augitic from the feldspathose parts; the former appearing as lenticular patches in a base consisting of the latter. This and other somewhat similar lavas in the same neighbourhood, give rise to important inferences as to the condition of such substances at the period of their emission from the earth. The solid tufa of Capo di Monte and other hills envelops shells of the same species with those which at present inhabit the Bay of Naples. It is likewise in some points traversed by vertical veins of a finer and harder matter, seeming to have exuded from the sides of a fissure formed in the rock, before it was completely desiccated.

The author attributes the formation of all these volcanic hills to successive eruptions from below the surface of the sea, though on a shallow shore: and, from the existence of loose tufa over the whole plane of the Campagna, and even to some distance up its principal valleys, he infers that the sea once washed the foot of the Apennines behind Capua; and that this plain has since suffered an elevation of 200 feet at least,—an elevation in which the whole western coast of Italy and the Apennines probably shared; as ap-



pears from the traces of lithophagi in the cliffs between Rome and Palermo, much above the present sea-level, and from other collateral testimony.

March 16.—W. P. Brigstock, Esq. of Stokes Hill, near Guildford, in Surrey; Robert Ingham, Esq. of the Inner Temple, London; James Overbury Anstie, Esq. of Devizes, Wilts; and James Backwell, Esq. of Charlotte Street, Blackfriars, London,—were elected Fellows of the Society.

A paper was read, "On the Geology of the vicinity of Pulborough, Sussex;" by P. J. Martin, Esq.

The author's object is to give a detailed account of the district on the north of the South Downs, extending from about Petworth on the west, to Steyning and the Adur on the east, and intervening between the portions of Sussex described by Mr. Mantell and Mr. Murchison. The structure of this tract agrees, in general, with part of the adjoining district on the west; but two of the formations are here subdivided into natural groups, which the author conceives ought to be distinguished; the following being the series in a descending order, which has come under his observation:—1. *Chalk*. 2. *Firestone*,—including upper greensand, and Malm-rock. 3. *Gault*. 4. *Shanklin sand*,—including, as subdivisions, ferruginous sand, and lower greensand and sandstone. 5. *Weald clay*.

The portion of the *Firestone*, which the author denominates Upper Greensand, may be traced distinctly as a thin bed at the foot of the chalk hills from Sutton to Washington, and is best exposed at the entrance of the Arundel defile, resting upon the Malm-rock,—an argillaceous limestone which extends into terraces in some places 50 feet thick and half a mile in breadth. The *Gault* is probably not more than 60 feet in its greatest thickness: it is widest on the E. of Sutton, and thence eastward varies in width from a few hundred yards to a quarter of a mile. The upper, or ferruginous, portion of the *Shanklin sand*, occupies the broadest space between the chalk and the weald, and is from one to three miles in width, its northern boundary forming a very distinct escarpment. The surface of these sands is distinguished by its barrenness; they vary much in consistency and colour, and the lower beds especially, are pervaded by seams of clay, and abound in a stone consisting of coarse, siliceous sand cemented by oxyd of iron. The lower division of this formation (green sandstone) has in some portions a strong external resemblance to the stratum immediately beneath the chalk. It constitutes a fertile arable country, and affords pure and copious springs. The upper part contains thick layers and nodules of limestone, chert, and clay resembling fuller's earth. The lower affords a compact building-stone, which has long been quarried at Pulborough: but further west, these beds pass into chert. This stratum has obviously suffered great disturbance; and one of its natural chasms, forming the valley of Greenhurst, and about 4 miles in length, points towards the outlet of the Arun, and might probably be taken advantage of to connect that river with the Adur. The demarcation between the lower part of the *Weald*

*clay* and the subjacent *Hastings' sands*, is not well defined in the tract which the author describes. A considerable bed of sand occurs within the clay at its upper part; after this comes in a bed of Sussex marble; and, lower down in the clay, a second layer of sand containing siliceous grit in thin beds,—beneath which, the principal beds of Sussex marble (about 18 inches in thickness) occur; and these are finally succeeded by blue, brown, and red clay, and micaceous sand, the commencement of the forest ridge.

The author gives a particular description of the defile of the Arun, the principal outlet of the Weald in the south of Sussex. This river traverses about 15 miles of a country almost mountainous, cutting across the ridges of the sand and the chalk escarpment nearly at right angles to the valley of the Weald. The gorge, where it enters the green sandstone, is more than 400 or 500 yards in width at the bottom; the banks rise quickly to the height of about 200 feet on the east, and on the west to about 400 or 500 feet. At Bury and Amberly, where the river penetrates the chalk, the hills are 600 or 700 feet high; the ravine having all the characters of a fissure. And, as the strata, in several cases of this description, rise on both sides towards the crack, the author supposes that the channels now existing on the surface, have been produced by the operation of some internal forces by which the beds were broken up and elevated; and that the drainage of the country by the present outlets, can be thus explained, without having recourse to a debacle, or to denuding operations: and he supports this hypothesis by reference to the local features of the country, illustrated by sections.

April. 6.—William Carpenter Row, Esq. of Baliol College, Oxford; W. A. Mackinnon, Esq. of Hyde Park Place, London; John Lindley, Esq. of Chiswick, F.L.S.; Neil Malcolm, Jun. Esq. M.P. of Duntroun Castle, Ayrshire; and The Rev. J. Mc Enery, of Torquay, Devon,—were elected Fellows of the Society.

M. C. Von Oeynhausen, of Berlin; and M. C. Von Dechen, of Berlin,—were elected Foreign Members of the Society.

The reading of a paper “On the magnesian limestone of the northern counties;” by the Rev. Adam Sedgwick, Woodwardian Professor in the University of Cambridge, was begun.

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April 20.—Lieut.-Gen. Sir Rufane Donkin, K.C.B. &c. of Park Street, Grosvenor Square; Major T. L. Mitchell, of the Quarter Master General's department, Assistant Surveyor General of New South Wales; and the Rev. W. Whewell, M.A. F.R.S., Fellow of Trinity College, Cambridge,—were elected Fellows of the Society.

The reading of Professor Sedgwick's paper, on the Magnesian Limestone, was continued.

A paper was read giving an account of the discovery of a number of fossil bones of bears, in the Grotto of Osselles, or Quingey, near Besançon in France, by the Rev. Dr. Buckland, Professor of Geology in the University of Oxford.

The author visited this cave in October 1826, for the purpose of applying to it the method of investigation, which his experience in other caverns had taught him to adopt with success in the pursuit of fossil bones.

The Grotto of Osselles is of vast extent, nearly a quarter of a mile in length, and made up of a succession of more than thirty vaults, or chambers, connected together by narrow passages, and running almost horizontally into the body of a mountain of Jura limestone, on the left bank of the Doubs near Besançon.

The only entrance to the grotto is by an irregular aperture about the size of a common door, in the slope of the hill about 60 feet from the river. The abundance and beauty of the stalactite in many parts of this cavern, have rendered it one of the most celebrated and most frequented of any in France; but before Dr. Buckland, no one had ever sought for bones beneath the crust of stalagmite, which in most of the chambers covers the floor.

On breaking for the first time through the stalagmite, the guides were much surprised to find the author's prediction verified, as to the existence of a thick bed of mud and pebbles, beneath what they had considered to be the impenetrable pavement of the cave, and still more so, to see that in every one of the only four places which he selected for investigation, this diluvium was abundantly loaded with the teeth and bones of fossil bears. These lie scattered through the mud and gravel, in the same irregular manner as the bones of bears lie in the caves of Franconia and the Hartz; and like them, are the remains of animals that appear to have lived and died in these caverns before the introduction of the diluvium. The bones were found no where in entire skeletons, but dispersed confusedly through the mud: They were from bears of all ages, and none bore marks of either having been rolled by water, or gnawed by the

teeth of hyenas, of which last-named animal Dr. Buckland found no traces in this cave, in the few spots which he examined.

Insulated teeth, ribs, and vertebræ, separate fragments of skulls, and epiphyses detached from bones, lay scattered through the mud and pebbles.

In one extensive grotto called the "Salle à danser," which from its size and dryness is selected by visitors to eat and dance in, there is neither stalactite on the roof, nor stalagmite on the floor, but simply a thick deposit of diluvial mud, containing the same bones as in the other chambers; this mud being very dry is intersected by narrow crevices descending from its surface; and the shells of eggs and nuts, and the bones of chickens, &c. that are carelessly thrown aside by visitors, have sometimes fallen into these fissures, where they lie in juxtaposition with the antediluvian bones. Some of these modern remains are also dragged by rats into holes made in the mud by themselves, or by rabbits, badgers, and foxes.

The author concludes by stating that the best rule to follow in pursuit of antediluvian remains in caverns, is to select the lowest parts in which any diluvium can have been accumulated, and there dig through the stalagmitic crust, and seek for teeth and bones in the mud and pebbles that lie below. He also proposes, as a test for distinguishing bones of this antiquity, their property of adhering to the tongue if applied to them after they are dry;—a property apparently derived from the loss of animal gelatine, without the substitution of any mineral substance, such as we find in bones imbedded in the regular strata. This test extends equally to the bones of the osseous breccia of caverns and fissures, and to those in all superficial deposits of diluvium, excepting such as are too argillaceous to have admitted the percolation of water; but the property of adhesion is rarely found in bones from recent alluvium, or from peat bogs, nor does it exist in human bones, which the author has examined from Roman graves in England, and from the druidical tombs of the ancient Britons, nor in any of the human bones which he has discovered in the caves of Paviland and Wokey Hole.

Dr. Buckland proposes to apply this test to the much disputed case of human bones, said by M. Schlotheim to have been discovered in the cave of Köstritz in contact with those of the rhinoceros and other extinct animals.

Dr. Buckland also found, in the collection of Professor Fargeaud of Besançon, some teeth of fossil bears from a mine of Pea-iron-ore in that neighbourhood; but could not visit the spot to ascertain whether this ore was extracted from a bed of superficial diluvium, or from a fissure. Such iron-ore abounds in the diluvium of the east of France; and in fissures at Plymouth, and near Spa.

May 4.—Thomas Bell, Esq. of New Broad Street, was elected a Fellow of the Society.

The reading of Professor Sedgwick's paper on the Magnesian Limestone was continued.

May 18.—G. J. Roupell, Esq. M.D. of Caroline Street, Bedford Square; and Isaac Lyon Goldsmid, Esq., of Dulwich Hill House, Camberwell,—were elected Fellows of the Society.

A notice was read “On a Whin dyke in Cooper Colliery, near Blythe, Northumberland,” drawn up from the information of Mr. Bryham, agent at the Cooper Coal Works, by W. C. Trevelyan, Esq. F.G.S. &c.

The total length to which this dyke has been traced is 1577 yards. It increases in breadth from S. to N.; being  $4\frac{3}{4}$  yards wide near the most southern point, where it has been cut through, and  $21\frac{1}{2}$  yards wide at the most northern spot hitherto observed. It is formed of two walls of greenstone, each from two to four feet in thickness; and these walls contain between them a breccia, composed of fragments of shale and whin, cemented by calcareous and argillaceous matter. Carburetted hydrogen and pure water issue from a narrow fissure in the broadest part of the dyke. The coal of the beds through which the dyke passes is charred, and deteriorated in quality, to the distance of about forty yards on each side.

The reading of a paper was begun, “On the fixed rocks of the Valley of the St. Lawrence, in North America,” by John J. Bigsby, Esq. M.D. F.G.S. &c.

June 1.—Henry Campbell White, Esq. of Comer-Hall, Hemel Hempstead; and Samuel Sharpe, Esq. of New Ormond Street, London,—were elected Fellows of the Society.

The reading of Dr. Bigsby’s paper, begun at the last meeting, was concluded.

The observations of the author in person were made principally in the Canadas, and on the northern shores of the great Lakes; and he connects with them a sketch from various authorities, of the regions which border the Valley of the St. Lawrence upon the S.W. and the lakes on the south and west of Upper Canada.

The north-western side of the St. Lawrence Valley consists principally of an arm of the primitive ranges which extend from Labrador and Hudson’s Bay to the sources of the Mississippi: and from this, at the outlet of Lake Ontario, a band is sent out across the Valley of the St. Lawrence to join the primitive formations of the United States. Numerous boulders of a limestone resembling the mountain limestone of England, are found on the north shore of Lake Erie; and this with other rocks in horizontal strata appears *in situ* at Lake Huron: the line of junction with the primitive rocks extending from Penitanguishene to Kingston, thence up the Ottawa to the Falls of the Chat, and the Longsault Rapids, from whence it stretches north-easterly to Cape Tourment in the north bank of the St. Lawrence 30 miles below Quebec.

The strata which overlie the transition rocks, in the St. Lawrence Valley, are, in a descending order, the following:—

1. Dark shale resting upon limestone, and containing terebratulæ, favosites, turbinolia, milleporites, trilobites, &c.; this extends for many miles, along the south of Lake Ontario and the south-eastern shore of Lake Erie.

2. Cherty limestone, beneath which is blue limestone with copper pyrites, and foliated strontian ;—this last containing producti, and corallines, in addition to the fossils above enumerated. The brown limestone of Niagara contains cellular madrepores, pentameræ, trochi, trilobites, &c. ; and the junction of this limestone with the shale is well seen beneath the table rock of the Niagara Falls. The shale on the south of Lake Ontario is from 120 to 250 feet in thickness. Its place is superior to that of the muriatiferous sandstone : and in this respect the author conceives the order of stratification here to be distinguished from that which obtains in Europe ; since the same fossil remains have not yet been found in Europe above the saliferous sandstone.

3. Arenaceous rocks, in the lower beds of which are brine springs. The stratum which forms the floor of the salt springs on the south borders of Ontario, varies from a red or greenish sandstone to a greenish or red clayey slate ; and is occasionally 80 feet in thickness.

4. Another group consists of a quartzose aggregate, from 40 to 60 feet thick, resting on grauwacke, either fine-grained or slaty ; the finer varieties containing the *asaphus latocaudatus*, *bellerophon*, and a bivalve resembling a *sanguinolaria*. No coal has been found in this vicinity.

5. Another portion of the stratified rocks is ranked by the author with the intermediary limestone of Daubuisson ; the higher beds containing organic remains resembling those of the transition limestone of Germany and Wales ; while none of the organic remains of the superior deposits are found in it. It occurs in many parts of Lower Canada, on the northern shore of Lake Ontario, Lake Simcoe, Lake Huron, and Lake Superior.

Near the outlet of Lake Ontario, cliffs upwards of 100 feet in height are formed of sandstone, grauwacke, and conglomerate ; and for many miles down the St. Lawrence these rocks underlie the intermediary limestone. At the Falls of Montmorency near Quebec, the conglomerate rests upon gneiss and other primitive rocks ; but at Malbay it is interstratified with brown limestone, and contains spiral univalves and various bivalves\*. The author is inclined to refer the formation to the old red sandstone.

The porphyries of Gros Cap and Nipigeon on Lake Superior, contain agate, chalcedony, fluor, green earth, and vitreous felspar : they are unstratified, and form serrated precipices. Near Gravel Point they much resemble some of the porphyries of Arran in Scotland.

The rocks of the St. Lawrence Valley, beneath the series above mentioned, consist, in a descending order, of grauwacke, intermediary limestone, quartz-rock, primitive limestone, and various slaty rocks,—including gneiss, mica slate, actinolite slate, with syenite, greenstone, and ophicalcic rock. The prevailing direction of the strata, for more than 1000 miles, from the River Saguenai, on the north of the St. Lawrence, to the northern shore of Lake Huron, is to the N.E. ; and the rocks are regarded by the author as the most

\* Some of the fossils of this formation have been figured in the Geological Transactions, 2nd Series, Vol. I.

recent of the primitive class. Quartz-rock prevails on the north of Lake Huron for more than 70 miles; and the islands in that part of the lake consist of fine-grained red and gray granite, with quartz-rock and trap: and vast masses of granite alternate with greenstone for a space of 300 miles on the north shore of Lake Superior. Of the slaty primitive rocks, the most abundant is gneiss; which constitutes some of the principal heights, and forms the mountains N.E. of Quebec, and lines the northern shore of the St. Lawrence. Cape Tourment, 1800 feet in height, consists of this rock; so also the outlet of Lake Ontario, and it skirts the north shore of Lake Simcoe and Huron, and occupies a considerable tract on the north of Lake Nipissing, and at the upper part of the river Ottawa.

The author supposes that the numerous boulders of Labrador felspar on the shores of Lake Huron, on the S.W. of Lake Simcoe, and even so far eastward as the outlet of Lake Ontario, have been derived from a tract about 60 miles west of Penetanegeneshene, where the gneiss passes into Labrador felspar, traversed by veins of pyroxene and garnet; and this he supposes to be the southern verge of a vast tract of the same composition. Magnetic iron ore is associated with syenite on the north of Ontario. Greenstone occurs in veins in Lower Canada: near Lake Huron it supports intermediary limestone; and it is found at Gros Cap in Lake Superior, and forms numerous dykes of great size in the north shore of that lake. A mass composed of a mixture of augite and hornblende occurs near Montreal, constituting Montreal Hill, 650 feet high, from which numerous dykes cut through the shelly deposits at the base of the hill.

The primitive limestone appears in every part of the St. Lawrence Valley to belong to one and the same epoch, and occupies a considerable space on the south-western frontier of Lower Canada, near Lake Champlain. In Upper Canada, the upper part of the river Ottawa has its course through this rock, and considerable masses of it occur in Crew Lake: the same white marble is seen at Lake Chat, and on the left of Lake Chauclière, on the river Calumet and on the river Gauanoque, about 18 miles below Kingston; it is blended with serpentine.

June 15.—The Hon. William Francis Spencer Ponsonby, of St. James's Square, London; William Terry, Esq. of High Wycombe, and Duke Street, St. James's Square; the Rev. Richard Gwatkin, B.D. Fellow and Tutor of St. John's College, Cambridge; the Rev. George Peacock, M.A. F.R.S. Fellow and Tutor of Trinity College, Cambridge; the Rev. Julius Charles Hare, M.A. Fellow of Trinity College, Cambridge; the Rev. John Hutton Fisher, M.A. Fellow of Trinity College, Cambridge; the Rev. Richard Sheepshanks, M.A. Member of the Astronomical Society, and Fellow of Trinity College, Cambridge; and Major General Sir John Malcolm, G.C.B. F.R.S. &c.,—were elected Fellows of the Society.

A notice was read, "On some fossil bones of the elephant and other animals, found near Salisbury:"—by Charles Lyell, Esq. F.R.S. F.G.S. &c.

Bones and teeth of the elephant, rhinoceros, and ox, have been

found for many years past in the brick-earth at the village of Fisherton Anger, at the distance of about  $\frac{3}{4}$  of a mile from Salisbury Cathedral. Several pits sunk in this brick-earth show that it varies in thickness in different places from about 10 to 20 feet. It bears every mark of a tranquil sedimentary deposit from water; but the laminæ are sometimes divided by thin layers of fine sand, or occasionally, but rarely, by a layer of small flint pebbles. There are no marine remains; but land-shells are said to occur sometimes in this deposit. The brick-earth rests upon a bed of chalk flints, the greater part of which are not water-worn: and beneath these is chalk, which is loose and rubbly in the upper part.

This brick-earth is not connected with the alluvial soil of the present valley, but appears to have been deposited when the valley was at a higher level; for it forms a low terrace, along the side of the river Willy, between Salisbury and Wilton, rising 30 or 40 feet above the present water-meadows. It is necessary at least to suppose that when these beds were accumulated, the water rose much higher than it now does.

The bones are in a very decomposed state, but have no appearance of having been rolled; they are found in the lower part of the brick-earth, and not in the subjacent flint gravel. And in one spot there is reason to believe that the remains of an entire skeleton of an elephant might have been procured.

A paper was read, entitled "Remarks on some of the strata between the chalk and the Kimmeridge clay, in the south-east of England:"—in a letter to Charles Lyell, Esq., from Wm. Henry Fitton, M.D. P.G.S. &c.—The objects of the author were; first, to ascertain in the interior, the existence of that remarkable group of strata, which on the coast has been found to include the remains of organized bodies supposed to belong to freshwater; and secondly, to trace along the western boundary of the chalk the strata which immediately succeed it. For the latter purpose, he gives a series of sections at right angles to the outcrop of the chalk, on the boundary of that formation passing from the coast of Dorsetshire, round the Blackdown hills in Devonshire, and thence by the vales of Wardour, Warminster and Pewsey, through Oxfordshire, Buckinghamshire, Bedfordshire, &c. to Hunstanton Cliff on the coast of Norfolk, where the course of the chalk range is interrupted by the sea. These sections prove that the order of the strata is throughout the same as in the Isle of Wight, and in Kent, Surrey and Sussex;—and the paper describes the principal variations in the proportions and characters of the beds, at the site of the several sections.

In proceeding westward from the Isle of Wight, the beds which intervene between the chalk and the Purbeck limestone appear to run together; and cannot well be distinguished further west than Lulworth Cove. Beyond that point no trace has yet been detected of any of the freshwater beds beneath the lower green-sand; nor is the separation of the upper from the lower of these sands by a stratum of clay (Gault) any longer discernible. Some fossils, however, of the gault occur in the *sands* on the coast near Lyme Regis, and at the well-known quarries of Blackdown; and the presence of the



gault itself beneath the upper green-sand is again distinct in the Vale of Wardour, and throughout the entire range from thence to Norfolk.

The only places in which the author has detected the presence of the freshwater beds succeeding the lower green-sand, are in the Vale of Wardour, and in the vicinity of Aylesbury: and it would appear that the great extent of the sands immediately beneath the chalk, shooting out beyond the subjacent strata, and concealing their outcrop, may be one cause why the group next in succession is but rarely visible in the interior;—though it is also probable that strata produced at the bottom of freshwater-lakes, or of æstuaries, were originally deposited in detached portions, comparatively of no great extent.

In the Vale of Wardour, the series consists of,—1. Chalk; 2. Upper green-sand; 3. Gault; 4. Traces of the lower green-sand (Shanklin sands); 5. Traces of the Hastings sands; 6. the Purbeck strata,—containing in great abundance freshwater shells, principally of the genus *Cyclas*, and in the upper part the *Cypris faba*: which remarkable fossil therefore pervades the whole group between the lower green-sand and the Portland stone; 7. Calcareous strata, containing the fossils of the Portland stone, and of the same mineralogical character with the beds of that formation in the Isle of Purbeck; 8. Clay, like that of Kimmeridge, &c.

The succession in the vicinity of Aylesbury is nearly the same with that of the Vale of Wardour; the Portland stone being covered at Whitechurch by beds of whiteish fissile limestone, containing freshwater shells, among which are *Cyclades*, and a species of *Cypris*. The Portland strata occur also at Brill Hill in Buckinghamshire, and at Garsington in Oxfordshire; and the remarkable nodules of Shot-over-hill, though differing considerably in appearance from the limestone of Portland itself, must probably be referred either to that formation, or to a group of strata which, from their abounding in green particles, might be confounded with some of the calcareous beds of the lower green-sand, but which, both in Buckinghamshire and on the coast of the Lower Boulonnois, occur beneath the equivalent of the Portland stone.

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At the close of this meeting, which terminated the session, the Society adjourned till Friday evening, the 2nd of November.

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# PROCEEDINGS

## OF

### THE GEOLOGICAL SOCIETY OF LONDON.

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1827—1828.

No. 4.

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November 2.—The Society having assembled this evening for the session :—

An extract was read, of “A letter from Captain P. P. King, R.N., to Dr. Fitton, P.G.S., dated at Rio de Janeiro, 10th June, 1827 :—with some observations on the specimens sent home by Captain King ; by the President.”

The expedition under Capt. King, for the purpose of surveying the Straits of Magellan, left Monte Video on the 19th of November, 1826 ; and after putting into Port St. Elena, about lat.  $45^{\circ}$  south, and remaining for a day or two in the vicinity of Cape Fairweather, continued for ninety days within the Strait ; during which time, its shores, to the east of Cape Froward, were surveyed under the superintendence of Capt. King himself ; while his consort, under Capt. Stokes, examined the western entrance. The map and specimens sent to England, contain the results of these operations ; and Capt. King intended to sail within a short time after the date of his letter, for the purpose of continuing the survey.

The coast at Port St. Elena is described by Capt. King as consisting of porphyritic claystone ; of which the hills, from 300 to 400 feet high, are entirely composed. The specimens from thence consist of claystone, compact felspar, and hyperstene rock ; and the beach affords a conglomerate, consisting of rounded fragments of these substances, cemented by carbonate of lime containing portions of shells, and resembling the recent calcareous conglomerates which abound on the shores of Asia Minor, Australia, and several other parts of the world.

Cape Fairweather is near the southern extremity of a range of coast, occupying between two and three degrees on the east of Patagonia ; a great part of which is described in the Admiralty Chart, as being “like the coast of Kent, and consisting of steep chalk hills ;” —one of the prominences being named, from a supposed resemblance, “Beachy Head.” This, however, from Capt. King’s statement, would appear to be erroneous :—the whole coast examined by him, was found to be composed of horizontal strata of clay, which may be traced for several miles in unbroken continuity ; the cliffs being from 300 to 400 feet in height, and entirely bare of vegetation. Some of the specimens, however, from this quarter, consist of a white marl, not unlike certain varieties of the lower chalk ; and with these,

are portions of a greenish sand-rock, much resembling that of the upper green-sand formation, and of a clay having many of the properties of fuller's earth. The pebbles of the shore consist of quartz, red jasper, hornstone, and flinty slate; but do not contain any stone resembling chalk flint.

Cape Virgins at the north-eastern entrance of the Straits of Magellan, consists of clay cliffs, like those of Cape Fairweather; and between these two Capes the coast is of the same character.

What may be called the eastern branch of the Straits, from Cape Virgins to Cape Froward, though its general course is from north-east to south-west, varies considerably in width and direction; but from thence to the western entrance, the direction is nearly straight, from south-east to north-west,—and the width much more uniform: and one of the principal points already determined by Capt. King's survey, is that the fissure constituting this portion of the Strait is continued in the same direction, for about a hundred miles towards the south-east from Cape Froward; through St. Gabriel's Channel, and a deep inlet, discovered by Capt. King and named "Admiralty Sound," which runs nearly fifty miles into the interior of Terra del Fuego. This separation of the land, by a narrow rectilinear channel of such great length, appears to be analogous to the division of Scotland, by the chain of Lochs on the line of the Caledonian Canal.

In proceeding westward from the eastern entrance, the coast gradually changes its character; and primitive rocks appear about Cape Negro near Elizabeth Island, where mountains of slate rise to the height of from 2000 to 3000 feet. Capt. King remarks that the direction of all the ranges, commencing at Port Famine about thirty miles from Cape Froward, is towards the S.E.; and that all the sounds and openings of the land in Terra del Fuego trend in the same direction; this being also the direction of the strata, which dip towards the south. This coincidence in the direction of the mountain ranges, has been carefully expressed on Capt. King's map; and he supposes that a similar structure holds good throughout the western branch of the Strait, from Cape Froward to the entrance on that side.

The specimens from Freshwater Bay, about 120 miles from Cape Virgins, on the Patagonian side of the Strait, consist of highly crystalline greenstone and hyperstene rock, resembling those of Scotland; and the pebbles and boulders on the shore, are of granite, hornstone, sienitic rock, quartz and flinty slate.

The vicinity of Mount Tarn and Eagle Bay, about midway between Port Famine and Cape Froward, affords also porphyritic and crystalline rocks, abounding in hornblende, or hyperstene; with grauwacke, siliceous slate, and gray splintery limestone.—The slate of Mount Tarn contains traces of organic remains. The specimens from the south side of this eastern branch of the Strait consist of mica-slate approaching to gneiss, found at the entrance of St. Magdalen's Sound, and at Card Point on the south-west of St. Gabriel's Channel. The rocks at Cape Waterfall near Card Point, are of clay-slate; and the shores of Admiralty Sound afford granite, and various porphyritic rocks, including clinkstone-porphyry, and greenish compact felspar. Capt.

King also mentions his having observed here reddish quartzose-sandstone, like that of the old red-sandstone formation of Europe : and he remarks, that the soil over this rock is barren, while that above the slate produces luxuriant vegetation ; beeches of great size growing there within a few feet of the water-side. In general, the hills in this part of Terra del Fuego appear to be of slate : they rise to the height of 3000 feet, and are covered with snow and ice. Mount Sarmiento, however, which is more than 5000 feet high, appears, from the shape of its summit, to be volcanic ; and was called by the navigator, after whom it was named, "The Snowy Volcano."

The specimens from the western branch of the Straits of Magellan, collected by Capt. Stokes, all consist of primitive rocks : Cape Notch, Cape Tamar, and the Scilly Islands affording granite ; Port Gallant, and Cape Victory, gneiss and mica-slate ; and Valentine's Bay, clay-slate much resembling that of Port Famine. These places are all on the north of the Strait. On the southern side, in Terra del Fuego, Cape Upright affords granite and gneiss ; and the latter rock is found also at Tuesday Harbour, and in the neighbourhood of Cape Pillar : the columnar mass, from which that remarkable point was named, is composed of mica-slate.

Of the specimens sent home by Capt. King from this remote quarter of the globe, it may be remarked, in general, that they agree perfectly with the rocks of Europe and other parts of the world ;—the resemblance amounting, in several cases, to almost complete identity.

The reading was begun of a paper "On the Geology of Tor and Babbacombe Bays, Devon ;" by H. T. De la Beche, Esq. F.R.S. &c.

Nov. 16.—The reading of Mr. De la Beche's paper, begun at the last Meeting, was concluded.

The coasts of Babbacombe and Tor Bays are composed of new red-sandstone, carboniferous limestone, old red-sandstone, and trap-rocks : and the sections presented by the cliffs exhibit various marks of disturbance, which the author conceives to have been caused by the intrusion of trap among the strata, subsequently to their deposition.

1. The *new red-sandstone* here consists of red conglomerate resembling that of Heavitree and Exeter, being made up of portions of old red-sandstone, carboniferous limestone, shale, quartz, grauwacke, and porphyry, with small crystals of felspar :—the whole cemented by a red paste, and occasionally interstratified with red-sandstone and marl. The conglomerate is regarded by the author as the lowest part of the new red-sandstone formation, and as the equivalent of the *röthe-tödteliegende* of Germany : and the fragments of porphyry included in it, are supposed to be the remains of pre-existing trap-rocks ; both from their rounded form, and their admixture with the detritus of other formations inferior to the new red-sandstone.

This red conglomerate occupies three small districts : 1. That of St. Mary Church and Watcombe. 2. Tor-Moham. 3. Paington.—The first extending along the coast from the Ness Point (Teignmouth) to Oddicombe Sands ; with the exception of an insulated mass of car-

boniferous limestone at Petit Tor, which is bounded by the conglomerate, and partially overlaid by it.

The conglomerate of Tor-Moham, connected with that of St. Mary Church by an isthmus, is of similar composition, and rests upon carboniferous limestone and old red-sandstone.

Near Paington, the conglomerate abuts against the old red-sandstone; and having fallen from the cliff in considerable quantity, near Livermeed and Preston Sands, has the appearance of underlying the latter.

*2. Carboniferous Limestone.*—The rocks of this formation in the neighbourhood of Torquay, have hitherto been regarded as belonging to the transition series; but the author supposes them to be identified with the carboniferous or mountain limestone, by their mineralogical characters and organic remains. The limestone is of a gray colour, traversed by numerous veins of carbonate of lime, is occasionally interstratified with marl, and generally reposes upon argillaceous shale,—the lower limestone shale of the carboniferous series. In the vicinity of trap, however, it assumes a semi-crystalline structure, and thus affords the numerous varieties of the well-known Babbacombe marble.

Very remarkable curves and contortions in the limestone strata are visible near Torquay; the disturbed beds in general dipping away from the old red-sandstone. And on the west of Babbacombe, the coast exhibits the limestone and shale in great confusion; particularly where it is in contact with the trap of the promontory called Black Head.

At Saltern-Cove, near Goodrington, the limestone is intermixed with, and disturbed by, trap,—which appears to have assumed the character of serpentine, and to have so altered the calcareous rock that it does not effervesce with acids.

The author gives a general list of the organic remains in this deposit: including trilobites, encrinites, corals, nautili, orthocerae, and several species of testaceous mollusca characteristic of the carboniferous limestone. A very singular fossil also is figured, which appears to have been attached in the manner of the *Alcyonia*; but whether it is to be classed with the corals, or considered as intermediate between the crinöidea and echinodermata, has not yet been determined.

The cavern called Kent's Hole, near Torquay on the N.E., lately celebrated from its containing the remains of various antediluvian animals, is in this carboniferous limestone.

*3. Old Red-sandstone.*—This formation, which occupies a considerable space in this country, is well exposed at Cockington, where the sandstone is compact, micaceous and siliceous, and associated with a slaty rock. Near Ockham, and N.N.W. of Paington, the lowest beds lose their red colour, becoming more schistose; and these, as well as the grit and slate of Meedfoot Sands, seem to pass into grauwacke. The old red-sandstone is extensively overlaid by unconformable beds of the new red conglomerate at Chelston near Cockington, and in other places.

*4. Grauwacke.*—At Westerland, there is a schistose and micaceous

variety of grauwacke, containing stems of encrinites, corals, and bivalve shells.

5. *Trap Rocks*.—The connection of these rocks with the disturbed state of the stratified deposits, constitutes the chief interest of the tract described in this paper. A small headland, east of Babbacombe, consists of greenstone containing much iron pyrites, and traversed by veins of quartz, jasper, &c.; the contiguous limestones being semi-crystalline. On the west of the same place, another headland is composed of porphyritic greenstone, occasionally amygdaloidal:—and here the trap is protruded upwards, into the overlying argillaceous slate of the carboniferous limestone; the adjacent beds of shale being broken, much contorted, and some portions of them even included in the mass of trap; whilst the limestone in the upper part of the cliff also is much dislocated. In the inaccessible cliffs near Oddicombe Sands, the trap has intruded itself among the limestone and shale, the beds of which are much altered in character, and so broken up near the summit, that they are with difficulty distinguished from each other. The largest mass of trap on this part of the coast is at Black Head; and is remarkable as inclosing a large detached portion of the contorted limestone.

Near to a great fault at Oddicombe Sands, the argillaceous slate is elevated to the top of the cliff, and the adjoining new red conglomerate also rises, as if forced up by the same movement which had affected the slate.

The author conceives that the appearances of the coast which he has described, point out two distinct geological epochs:—1st. That of the formation of the new red conglomerate, after the limestone and shale had been partially broken up. 2ndly. The intrusion of the trap, at a period subsequent to the deposition of the conglomerate and new red-sandstone. And besides attributing the disturbed state of this region to the operation of trap, the author is disposed to refer to the same period and agency, the great dislocations in the oolitic series on the east of the tract which he has described; and to connect with the convulsion by which he supposes that disturbance to have been produced, the greater catastrophe which elevated the chalk of the Isle of Wight,—and even, possibly, that which threw up the main ridge of the Alps.

A paper was read, entitled, “*Supplementary Remarks on the Strata of the Oolitic series, and the Rocks associated with them, in Sutherland, Ross, and the Hebrides;*” by Roderick Impey Murchison, Esq., Sec. G.S. F.R.S., &c.

The author, in company with Professor Sedgwick, having visited, during the last summer, the districts which he described in a former memoir (*Geol. Trans.* 2nd series, vol. ii. part 2.), has been enabled to make some additional observations, and to collect further specimens illustrative of the strata of the oolitic series, and their associated rocks in the north of Scotland.

1. *On the connexion of the primary rocks with the secondary deposits, on the east coasts of Sutherland and Ross*.—The Ord of Caithness, and the mountainous ridge connected with it, which had

been described as consisting of a rock made up of felspar, quartz, and a decomposing green substance, is now ascertained to contain well-crystallized mica. This granite, on its northern flank, supports the old red conglomerate; whilst to the south it occupies a cliff, on and near the shore, the verge of which affords a remarkable breccia, compounded from all the beds of the oolitic series that occur upon this coast. These appearances were cursorily noticed in the author's paper above referred to; they are now described more in detail: and it is shown, that this breccia of sandstone shale, fossils and limestone, is tilted off from the granite, wherever that rock protrudes upon the shore; whilst the strata are regularly developed when the granite recedes into the interior. And since the amount of disturbance is in every case proportioned to the greater or less proximity of the granite, the author infers, that this rock was elevated subsequently to the deposition of the oolitic strata. Thin beds of primary slaty rocks have been observed in several places, interposed between the secondary beds and the granite: and the greater portion of the Sutors of Cromarty consist of felspathose gneiss; which rock, however, is in some situations so much charged with veins of granite, that the whole has a granitiform aspect, whilst in other places the mass when decomposed strongly resembles the rock of the Ord of Caithness above mentioned.

That the granite of this coast has been elevated, is further rendered probable, by the position of the red conglomerate on the tops of the granitic mountains; thus giving to that deposit the appearance of overlying the more recent formations of the oolitic series, to which they are in fact superior in point of height above the sea.

Without dissenting from the opinions of other geologists, as to the formation of veins in gneiss by the injection of granite in a state of softness, the author states that Mr. Sedgwick and himself were led to a different hypothesis, in order to account for the appearance of the brecciated secondary beds in contact with the granite of this coast: and they suppose that the latter rock must have been upheaved, not in a liquid form, but in a state of solidity, since no veins or portions of the granite are to be met with in or above the breccia.

2. *Denudation of Braambury, and Hare Hills*.—These hills, the highest in geological position of the Brora district, and celebrated for their quarries of white siliceous sandstone abounding in fossils, afford, upon their sides and summits, distinct traces of a strong diluvial current; which has swept them free of covering matter, and deposited in the plain of Clyne Milltown, a mass composed of the debris of the denuded hills, mixed with boulders of the coarse red conglomerate. A large portion of the turf having recently been removed, the surface of the rock is now seen to be scored with parallel lines, precisely similar to those observed in other places, and described by Sir James Hall, Dr. Buckland, &c. And in this case, although the surface of the ground is very unequal, and the dip and bearings of the denuded strata vary considerably, the direction of the markings is uniformly from N.N.W. to E.S.E.

3. *Hebrides, and Mainland of the West Coast*.—Pitchstone, a mineral not previously found in Scotland in association with the more



recent stratified rocks, has been discovered by Professor Sedgwick and Mr. Murchison in two places ; forming portions of trap dykes,—one of which cuts through the lias and inferior oolite at Carsaig Mull ; the other traverses the cornbrash and forest-marble, at Beal near Portree in Skye.

The identity of the various secondary strata in the Isles of Mull, Skye, Pabba, Scalpa, Rasay, &c., is now established by the numerous organic remains which they have been found to contain; many of which belong to new species, but the greater number are well known as characteristic fossils of the oolitic formations in England.

The former vast, and perhaps continuous, extent of these deposits on the western coast, is further rendered probable, by their having been observed by Professor Sedgwick and the author, on the N.E. coast of Mull, at and near Tobermory ; and at Applecross on the west coast of Ross-shire. In the latter place, lias-limestone, similar to that on the opposite shores of Skye and Rasay, rests conformably upon the new red conglomerate ; and as the same fact had been previously remarked on the east coast, near Cromarty, evidence is thus afforded that the members of the oolitic series of Scotland, generally, were of subsequent formation to that great mechanical deposit ; being lodged, apparently, in the basins or undulations presented by its surface.

A letter was read from G. W. Featherstonhaugh, Esq. to W. H. Fitton, M.D. P.G.S. &c. ; containing an account of an excavation in the chalk at Norwich.

The writer, having learnt that an extensive cavity in the chalk of Heigham Hill near Norwich, had been discovered about four years ago, in consequence of the workmen who were digging a well, having suddenly sunk into a vault, examined the place ; and he describes the excavation as consisting of various galleries, (a plan of which is annexed to his letter,) of about eight feet in height, from two to five feet in breadth, and occupying a total length of 4600 feet. He conceives that the object of this laborious work, was to extract the flints, which were used in great quantity in the construction of the ancient buildings and walls of Norwich ; since the nodules of flint have been almost entirely removed from the catacombs, while the chalk itself is left. And he states in support of this opinion, that upon re-opening the original entrance, which had been blocked up by ruins, the date 1571, with the name of one of the workmen, was found written on the side of the cavern :—a year which corresponds with a period, when the walls of the town are known to have been repaired with flints, and various buildings formed of them.

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# PROCEEDINGS

## OF

### THE GEOLOGICAL SOCIETY OF LONDON.

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1827—1828.

No. 5.

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1827. Dec. 7.—John Braddick, Esq. of Boughton-Mount near Maidstone; G. W. Featherstonhaugh, Esq. of Duanesburgh, New York; Arthur Kett Barclay, Esq. of Grosvenor Place, London; and Lord Francis Leveson Gower, of Albemarle Street, were elected Fellows of the Society.

A paper was read, "On the Geology of Quebec and its Vicinity, by J. T. Bigsby, M.D. F.L.S. G.S." &c. &c.

The author, who acknowledges the assistance he has derived from the manuscripts of Lieut. Skene, R. E., first describes the tract, on the eastern termination of which the city of Quebec is situated, as an oblong ridge of about seven miles and a half in length, and in average width about one mile and a half; subsiding on the north-west, by steep and rocky slopes, into rich meadows; whilst on the south-east it advances in the form of cliffs towards the northern bank of the St. Lawrence.

Several rivers traverse the district above mentioned, nearly from north to south, of which the most considerable are the St. Charles and the Montmorenci. On the southern bank of the St. Lawrence, Point Levi is the most conspicuous promontory; and to the west of it, the country is intersected by several streams running from south to north.

The districts above mentioned are partially covered with boulders of gneiss, granite, syenite, and labrador felspar; the greatest quantities of which are found on and near Cape Diamond, Point Levi, and Point Montmorenci; whilst occasional deposits of clay, gravel, and sand, including organic remains, the author supposes to be of diluvial origin,—and not produced by the operation of any existing watercourses.

The rocks of this region repose upon each other in the following descending order:—1st. A slaty series, composed of shale and grauwacke, occasionally passing into a brown limestone, and alternating with calcareous conglomerate in beds, some of which are charged with fossils.—2nd. A conchiferous brown and black limestone, sometimes based upon a calcareous conglomerate.—3rd. Gneiss. The author's chief reason for considering the slaty-series as superior to the limestone, is, that the latter is in some situations in immediate contact with gneiss; while in others it passes into beds of the first series above mentioned; the conglomerates of which contain organic remains derived from the conchiferous limestone.

1. The slaty-series occupies the whole of the southern shore of the

St. Lawrence, the Island of Orleans, and a considerable portion of the north bank of the river, including the ridge upon which Quebec is placed. In that neighbourhood the mass of the deposit consists of a black and brown slaty limestone, inclined at very high angles, and alternating with semi-crystalline limestone, and various conglomerates. The limestone contains several varieties of crystallized carbonate of lime, intermixed with quartz crystals, and occasionally traversed by seams of bituminous matter. Near Cape-Rouge, and on the plains of Abraham and Kilgraston, some of the strata consist of red and greenish clay-slate. In the calcareous conglomerates, organic remains are mixed with fragments of clay-slate; and the beds alternate with compact gray limestone and quartzose layers. Between Quebec and Cape-Rouge, boulders of primary rocks, and fragments of compact grauwacke, are buried deep in the red schist.

The channels of the various streams east and west of Quebec, afford instructive sections, which, according to the author, prove these slaty deposits to be more recent than the conchiferous limestone.

On the south side of the river St. Lawrence, the slaty limestone of Quebec is no longer seen; but several new beds of conglomerate present themselves, one of the lowest of which contains trilobites, encrinites, corallines, and other fossils,—associated with vegetable impressions, probably of *fuci* and *amansæ*. In the schistose beds near the mouth of the Etchemin are thin seams of coal; and at the village of St. Henry the slate is so compact as to be used for hones.

2. The horizontal conchiferous limestone occupies a zone from two to three miles in breadth, on the north of the slaty tract, and included between the slate and a mountainous range of gneiss. It is exposed in the beds of all the rivers which flow southwards into the St. Lawrence, and its characters are well developed at the falls of the Montmorenci and the St. Charles, and at the quarries of Beaufort. The organic remains consist of several species of trilobite, orthocera, terebratula, encrinite, ammonite, &c. On the Montmorenci the beds are nearly horizontal, from eighteen inches to two feet in thickness, and of a blackish-brown colour; in one situation they pass into a subjacent calcareous conglomerate, whilst in other places the limestone itself contains large blue nodules, and reposes immediately upon gneiss. At Beaufort-quarries, ledges of fetid limestone alternate with calcareo-bituminous shale, containing organic remains similar to those noticed on the Montmorenci.

From the characters and fossils of the limestone above described, the author regards it as the same with the *calcaire intermédiaire* of D'Aubuisson,—and the equivalent of the “Carboniferous-limestone” of English geologists.

Dec. 21.—Henry Holland Stutzer, Esq. River-Terrace, Islington, was elected a Fellow of the Society.

The reading was begun of a paper “On a Group of Slate-Rocks in Yorkshire, between the Rivers Lune and Wharfe, from near Kirby Lonsdale to near Malham,”—by John Phillips, Esq. Hon. Mem. of the Yorkshire Leeds and Hull Philosophical Societies.

1828. Jan. 4.—John Murray, Esq. Jun. of Albemarle Street, London; Henry Tuffnell, Esq. of Christchurch, Oxford; The Right Hon. Viscount Cole, of Christchurch, Oxford; R. C. Fergusson, Esq. M.P., of Craigdarroch, Dumfriesshire, and of Great Cumberland Street, London; John Phillips, Esq. of York; and John Gurdon, Esq. of Assington Hall, Suffolk,—were elected Fellows of the Society.

The reading of Mr. Phillips's paper, begun at the last meeting, was concluded.

The object of this paper is to describe the geological structure and relations of a group of rocks, which the author characterizes as “aberrant from the slate district of Cumberland,” and extending about fifteen miles towards the east under the summits of Greygarth, Ingleborough, and Pen-y-gant;—a tract remarkable for the variety and singularity of its geological appearances, among which the proofs of dislocation are peculiarly striking and important.

To this description a sketch is premised of the slate-series of the Lakes of Westmoreland and Cumberland; where the rocks are grouped in three principal divisions, the lowest consisting of dark soft slate much contorted, with fine-grained gneiss beneath it passing into granite. The second division occupies a country of very different aspect from that of the slate: the mountain-ranges being marked by abrupt precipices, as at Helvellyn, Langdale-Pikes, and the Lakes of Ulswater, &c. and consisting of brecciated argillaceous rocks containing calcareous spar, green-earth, and calcedony, with greenstone and other forms of trap. On the south of this chain is a tract of transition limestone, containing caryophylliæ, productæ, spiriferæ, and other fossils; and this is covered by a third zone of slate, the most recent rock of the country, usually divisible into rhomboidal blocks, of which two principal varieties are observable, alternating with each other; the one homogeneous and fissile, and containing organic remains sparingly distributed, of the genera *trigonia*, *pecten*, *gryphea*, *turritella* and *terebratula*;—the other more granular and micaceous. This formation is in some cases succeeded by red conglomerate, but more commonly by mountain-limestone, the lowest beds of which contain numerous pebbles of slate and quartz; and above the limestone are the carboniferous rocks, including the millstone grit and the upper coal-measures. The highest strata known in the country, consist of the new red sandstone, placed in an unconformable position above the coal formation.

The tract, which is the more immediate object of this paper, extends from the valley of the Lune in an easterly direction, to that of the Wharfe. Along its middle, from Casterton Fells to a few miles east of the Ribble, ranges an almost continuous line of argillaceous rocks, generally fissile, and belonging to the third division of slates above mentioned. This tract is bounded on the north by the elevated strata that support the summits of Greygarth and Pen-y-gant; and on the south (in consequence of great dislocations) by millstone grit and the coal measures. If the rivers Lune and Wharfe are included, no fewer than nine streams cross the district from north to south, and exhibit

very distinctly the structure and relations of the rocks ; the greater number of the streams cutting through the limestone and millstone grit, exposing the subjacent slate, and finally passing off on the depressed strata of the coal measures. The author describes in detail the phænomena presented in these several sections, and illustrates his observations by sectional views and sketches.

The structure of the country is very well displayed in the course of the Ribble ; where, on the north, the slate first appears beneath parallel bands of limestone ; while on the south, the carboniferous strata, the northern portion of which is horizontal, decline at a high angle, thus indicating a vertical dislocation of about four hundred feet. Besides this fault on the southern verge of the slate, another still more important one in a parallel direction, may be traced across the valley of Ribbles-dale, and over Malham Moor ;—by which, strata have been brought into immediate opposition, that in their original place were separated by a thickness of more than five hundred feet. Various facts are stated by the author in proof of this derangement, and descriptive of the phænomena produced by it.

The author subjoins to his descriptions some remarks on the stratification of slate, and on the difficulty of discriminating between the planes of general stratification, or dip, and those of the cleavage effected by a blow,—the latter of which are often disposed at considerable angles to those of the dip. He is disposed to think, that in the fissile granular varieties of slate approaching to sandstone, the laminæ of cleavage may really be those of deposition ; since the surfaces are frequently coated with mica, and the fossil remains are in a disposition parallel to them. Besides this more general cleavage, however, the slate is also traversed by other planes, oblique to those of the cleavage, and less conspicuous,—to which the quarry-men give the name of “Bate.” The direction of these planes, though nearly alike in limited spaces, is found to vary considerably in different portions of the same tract ; and even the better-defined planes of the ordinary cleavage are seldom parallel to each other throughout any great extent of country.

A collection was exhibited at this meeting, of fossil vegetables, chiefly from the Jarrow and Felling collieries, in the Northumberland and Durham coal-field, presented to the Society by William Hutton, Esq. of Newcastle-upon-Tyne ; with a catalogue describing the plants according to the system of M. A. Brongniart, and drawings, with some remarks by the donor.—The collection consists of specimens of *Calamites*, *Sigillariæ*, *Sagenariæ*, *Stigmaria*, *Filices*, *Sphærophylla*, *Asterophylla*, &c. ; and includes several undescribed *confervæ*, leaves, stems, &c.

Jan. 18.—A notice was read “On the Occurrence of ‘Chlorophæite’ in Basaltic Dikes, in Northumberland ; and of Carbonate of Strontian in the Lead Measures at Fallowfield near Hexham,”—by William Hutton, Esq. of Newcastle-upon-Tyne.

The author discovered ‘Chlorophæite’ in a basaltic dyke near the river Coquet, about two miles N.E. of Felton ; in the form of small

nodules, which upon fracture exhibit the changes of colour and appearance mentioned by Dr. MacCulloch, who first discovered this mineral in the Isle of Rum. This substance has also been observed by the author at Coaley-hill near Newcastle, in the steatitic or earthy form, and but rarely crystallized.

The reading was begun of a paper "On the Geological Relations of the Secondary Strata in the Isle of Arran;"—by the Rev. A. Sedgwick, V.P.G.S. F.R.S. Woodwardian Professor, and Roderick Impey Murchison, Esq. Sec. G.S. F.R.S. F.L.S. &c.

Feb. 1.—The reading of Professor Sedgwick and Mr. Murchison's paper, begun at the last meeting, was concluded.

This paper consists of three divisions: 1st. A brief outline of the general structure of the Isle of Arran. 2d. An account of the section on the N.E. coast of the island. 3d. Concluding remarks explanatory of the probable causes, and geological epochs of the several phenomena. In the 1st division, the authors, considering that the subject has been amply elucidated by Jameson, MacCulloch, and Hendrick, confine themselves to such details as are necessary to make their subsequent description intelligible. In the 2d part, the strata on the N.E. coast are described in great detail, for the purpose of comparison with the corresponding members of the English Series; from whence it appears, that a succession of formations, analogous to the old red sandstone, carboniferous series, and new red sandstone, are exhibited twice over, in an anticlinal section.

The mineralogical centre of this section is at North Sannox, and the lower red conglomerate is there seen in several situations, rising to the height of about 1000 feet above the sea. 1. This formation is supposed to be identified with the old red sandstone; from its lowest members graduating into grauwacke; from its containing concretionary limestone not distinguishable from the cornstone of Herefordshire; and its being regularly overlaid by the carboniferous series. 2. The middle deposit of the section is clearly referable to the carboniferous series, by its mineralogical structure, by the organic remains in the calcareous beds, which are identical with those of the mountain-limestone; by its containing seams of coal, which have been worked; and by the plants in the shale being of the same species with many of those most abundant in the coal-measures of England. 3. The superior sandstone and conglomerate are of enormous thickness, rising into lofty and precipitous hills upon the coast. These are referred to the new red sandstone, from their position and internal characters; and this classification is confirmed particularly by the structure of the sandstone on the southern coasts of the island. This formation differs however from the new red sandstone of England, not only in being conformable to the beds on which it rests, but also by graduating into the superior parts of the carboniferous order.

In conclusion, the authors endeavour to show, that the great dislocations of the secondary deposits have been produced by an upheaving of the granite; and they state, in corroboration of this

opinion, that where the breaks in the strata are greatest, there the granite makes the nearest approaches to them. It is further attempted to be proved, that the granite could not have been in a perfectly fluid state at the period of its elevation, from the fact of its existence in the form of mural and serrated precipices on the flanks of the secondary strata ; being in this respect prominently distinguished from the trap of the southern regions of the island, which has, in numberless places, not only penetrated, but overflowed upon the new red sandstone.

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ERRATUM IN THE "PROCEEDINGS," No. 4.—*Page 35, line 16 & 17.*

*for "rest conformably on the new red conglomerate,"  
read "rest upon the red conglomerate".*



# PROCEEDINGS

## OF

### THE GEOLOGICAL SOCIETY OF LONDON.

1827—1828.

No. 6.

*At the Annual General Meeting of the Fellows, 15th February 1828 ;*

A REPORT from the Council was read, of which the following is an abstract.—

“ Comparative Statement of the number of the Society, at the last and present Anniversaries.

Fellows.	16th Feb. 1827.	15th Feb. 1828.
Having compounded .....	42.....	44
Contributing .....	133.....	150
Non-resident .....	200.....	211
	375.....	405
Honorary Members .....	57.....	55
Foreign Members .....	46.....	47
	Total 478.....	507

“ The Names of the Fellows deceased within the past year are as follow :—

Dr. Clarke Abel.	Rev. Thomas Leman.
Captain Apsley.	Abraham Mills, Esq.
Morris Birkbeck, Esq.	Daniel Moore, Esq.
Sir Harry Calvert, Bart.	Robert Morison, Esq.
Rev. Dr. Haggit.	M. le Chevalier Luis D'Onis.
Right Hon. Geo. Knox.	John Harrison Thompson, Esq.

Honorary Members deceased :

John Hawker, Esq.	Joseph Wilkinson, Esq.
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Foreign Members elected :

M. Charles von Oeynhausén.	M. Henry von Dechen.
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Foreign Member deceased :

Signor G. Brocchi.

"The Report of the Auditors exhibits the following Statements,—from the 1st January to the 31st December 1827.

RECEIPTS.				PAYMENTS.			
Balances in hand Jan. 1, 1827 :				Bills of 1826 ; outstanding Jan. 1, 1827 .....			
Banker .....	£	s.	d.	£	s.	d.	£ s. d.
Collector .....	48	15	0				242 16 8
Mr. Webster .....	31	10	0				
	41	13	6				
	<u>121 18 6</u>						
Arrears of Contributions for 1826. ....							
Ordinary Income :	£	s.	d.				
Annual Contributions 1827 .....	390	12	0				
Admission Fees .....	258	6	0				
Compositions .....	98	14	0				
Dividend on Stock .....	29	4	6				
	<u>776 16 6</u>						
Rents received .....							670 18 2
Sale of " Transactions " .....	140	0	0				180 0 0
	406	2	6				
	<u>546 2 6</u>						
Sale of Stock .....							518 1 1
	<u>£1476 7 6</u>						
	562	12	8				£1611 15 11
Balances in hand ; 1st Jan. 1828.							
Banker .....	£	s.	d.				£ s. d.
Clerk .....	432	2	0				432 2 0
	30	2	3				30 2 3
	<u>462 4 3</u>						462 4 3
Deduct, apparent balance of an account to be settled. ....							£2074 0 2
							35 0 0
							£2039 0 2

"VALUATION of the Society's Property ; 31st December 1827.

PROPERTY.

	£	s.	d.
Cash in Hand. (See last page.)	462	4	3
Arrears due to the Society :	£	s.	d.
of Admission Fees	121	16	0
of Contributions	95	14	0
	<u>217</u>	<u>10</u>	<u>0</u>
of Rents	90	0	0
Estimated value of unsold "Transactions" already published	307	10	0
	<u>616</u>	<u>0</u>	<u>0</u>

[N.B. The value of the Lease, the Collections, Library, and Furniture, is not included here.]

DEBTS, &c.

	£	s.	d.
Miscellaneous	142	15	10
Bills outstanding	33	15	0
Clerk's Salary, &c.	10	17	6
Contributions overpaid, to be refunded.	31	18	8
Transactions and Proceedings	<u>219</u>	<u>7</u>	<u>0</u>
Rents owing by the Society	45	0	0
	<u>264</u>	<u>7</u>	<u>0</u>

Balance in favour of the Society . . . . . 1121 7 3

£1385 14 3

# ESTIMATES for the ensuing year: to 31st December, 1828.

## Income expected.

	£	s.	d.
Arrears due to the Society 31st Dec. 1827.			
Fees, Contributions, and Rents: (See last page.)	307	10	0
Ordinary Income (estimated.)	£	s.	d.
Contributions (of 155 Fellows.)	450	0	0
Admission fees :			
of Residents (twelve) ..	75	12	0
of Non-residents (twelve)	126	0	0
	651	12	0

Compositions estimated (three) ..... 94 10 0

Rents 1828 .....	140	0	0
Sale of "Transactions" .....	400	0	0

£1593 12 0

## Expenses, estimated.

	£	s.	d.
Debts outstanding and Rent owing, 31st Dec. 1827. (See last page) .....	264	7	0

General Expenditure :	£.	s.	d.	£.	s.	d.
House .....						
Repairs .....	200	0	0			
Taxes and Insurance	116	0	0			
				316	0	0

## Salaries and Wages.

Clerk .....	100	0	0
Collector ..	20	0	0
Servants' Wages } and Board ..	130	0	0
	250	0	0
Coals, &c. ....	70	0	0
Stationery, &c. ....	30	0	0
Miscellaneous .....	60	0	0
	726	0	0

Rents 1828 .....	180	0	0
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## Publications :

Transactions .....	400	0	0
Proceedings .....	20	0	0
	420	0	0

Balance in favour of the Society ..... 3 5 0

£1593 12 0

“The MUSEUM has received many valuable donations since the last Anniversary, of which the following are the most important :—

### *I. British Specimens.*

- “Portion of a large Head of the *Ichthyosaurus Platyodon* ; presented by H. T. De la Beche, Esq., F.R.S. G.S. &c.  
 Fossil bones of the *Hyæna* and other Animals, found in a cave near Maidstone ; presented by John Braddick, Esq. F.G.S.  
 Specimens from the Strata between the Chalk, and the Kimmeridge Clay, from the vicinity of Folkstone, the Vale of Wardour, Berkshire, and other places ; in illustration of a Paper read before the Society ; presented by W. H. Fitton, M.D. Pres. G.S. &c.  
 Fossils from the ferruginous sandstone of Parham Park, and Pulborough Mount, and from the lower green-sand of Pulborough ; presented by P. I. Martin, Esq. of Pulborough.  
 Additional Fossils of the Oolitic series in Scotland, and Rocks associated with them ; to illustrate a Paper read before the Society ; presented by R. I. Murchison, Esq. Sec. G.S. F.R.S. &c.  
 Specimens of Fossil vegetables from the Northumberland and Durham Coal-Field ; arranged and presented by W. Hutton, Esq. of Newcastle-on-Tyne.  
 Specimens from Arran, to illustrate their memoir on the secondary strata of that island :—presented by the Rev. A. Sedgwick, Woodwardian Professor, Cambridge ; and R. I. Murchison, Esq. Sec. G.S. F.R.S. &c.

### *II. Foreign Specimens.*

- “Specimens of Volcanic Rocks from Auvergne ; presented by G. P. Srope, Esq. F.G.S. &c.  
 A specimen of Apennine Landscape-Limestone from near Placentia ; presented by the Rev. W. Buckland, D.D. F.R.S. and L.S. Professor of Mineralogy and Geology in the University of Oxford.  
 Specimens of Rocks collected during his survey of part of the Straits of Magellan ; presented by Capt. P. P. King, R.N.  
 Specimens of Fossil bones, wood, and shells, from Ava ; presented by J. Crawford, Esq. F.G.S.  
 Specimens and Fossils from Spitzbergen, obtained during the late Northern Expedition ; presented by Capt. Parry, R.N. and Capt. Foster, R.N.  
 A series of specimens collected during the late Expedition to the North-west coast of America ; presented by Capt. Franklin, R.N. and Dr. Richardson.

### *III. British and Foreign Specimens.*

- “A legacy of recent shells, fossil organic remains, and minerals ; left by the late Capt. Apsley, F.G.S.  
 “The LIBRARY has been increased by the donation of 49 volumes.

“The second Part of the Second Volume of the New Series of TRANSACTIONS has been published since the last Anniversary; and directions have been given for putting to press the third and concluding Part which will contain an Index to the whole volume, and discharge, with very few unavoidable exceptions, all the unpublished arrears of papers, to the end of the last session.

“The circulation of the printed PROCEEDINGS of the Society has given such general satisfaction, that the Council has had no hesitation in recommending the continuance of it; since a record is thus obtained of the progress of the Institution, which may hereafter become an object of reference, with a view to the history of the subject; whilst an opportunity is afforded of circulating with promptitude, notices of transitory interest, or that require immediate attention; and of giving publicity to various papers on geological subjects, too valuable to lose, but not of sufficient importance to occupy a place in the more permanent and costly record of the Transactions.

“It is requested that such Members as do not now receive the Proceedings, and may be desirous of obtaining them in future, will leave with the clerk, some address in *London*, to which they may be directed, as heretofore, through the medium of the two-penny post.

“*Papers read at the Meetings of the Society since the last Anniversary.*

On the Volcanic district of Naples; by G. P. Scrope, Esq. F.R.S. G.S. &c.

On the Geology of the vicinity of Pulborough, Sussex; by P. I. Martin, Esq.

On the Magnesian Limestone of the northern counties; by the Rev. A. Sedgwick, Woodwardian Professor, Cambridge.

On the discovery of fossil bones near Besançon in France; by Professor Buckland.

Notice of a Whin Dyke in Cowpen Colliery near Blythe, in Northumberland; by W. C. Trevelyan, Esq. F.L.S. G.S. &c.

On the fixed rocks of the valley of St. Lawrence in North America; by J. F. Bigsby, M.D. &c.

On some Fossil bones of the Elephant, and other Animals, found near Salisbury; by Charles Lyell, Esq. F.G.S. &c.

Remarks on some of the strata between the Chalk and the Kimmeridge clay, in the South East of England; by W. H. Fitton, M.D. F.G.S. &c.

Extract of a Letter from Capt. P. P. King, R.N. to Dr. Fitton, P.G.S. dated at Rio Janeiro 10th June 1827; with some observations on the specimens sent home by Capt. King; by the President.

On the Geology of Torr and Babbacombe Bays, Devon; by H. T. De la Beche, Esq. F.R.S. &c.

Supplementary remarks on the Strata of the Oolitic Series and the rocks associated with them in Sutherland, Ross, and the Hebrides; by R. I. Murchison, Esq. Sec. G.S. &c.

A Letter from G. W. Featherstonhaugh, Esq. containing an account of an Excavation in the chalk at Norwich.

On the Geology of Quebec and its vicinity ; by Dr. Bigsby.

On a group of Slate-rocks between the rivers Lune and Wharfe, in the north of England, from near Kirby Lonsdale to near Malham, &c. ; by John Phillips, Esq. Hon. Mem. of the Yorkshire, Leeds and Hull Philosophical Societies.

A notice of the occurrence of Chlorophæite in basaltic Dykes, in Northumberland ; and of Carbonate of Strontian in the Lead Measures near Hexham ; by W. Hutton, Esq. of Newcastle-upon-Tyne.

On the Geological relations of the secondary strata, in the Isle of Arran ; by the Rev. A. Sedgwick, V.P.G.S. &c. Woodwardian Professor, and R. I. Murchison, Esq. Sec. G.S. &c.

“ The following List contains the Names of all the Persons, from whom Donations to the Library and Museum have been received during the past year.

Aikin, Arthur, Esq.  
Allan, Robert, Esq.  
American Phil. Society.  
Andreossy, Comte.  
Apsley, Captain.  
Asiatic Society.  
Astronomical Society.

Backwell, Joseph, Esq.  
Bathurst, Charles, Esq.  
Beaufort, Captain, R.N.  
Benett, Miss.  
Bichenso, J. E., Esq., F.R.S., Sec.  
L.S. &c.  
Biddle, N., Esq.  
Bouillet, M. J. B.  
Braddick, James, Esq.  
Bristol Institution.  
Brongniart, M.A., For. Mem. G.S.  
Brooke, Captain De Capell.  
Brooke, Henry James, Esq.  
Buckland, Rev. W., D.D. F.R.S.  
&c.  
Bullock, W., Esq. F.L.S.

Cambridge Phil. Society.  
Cazalet, Mrs.  
Cole, Viscount.  
Cordier, M. L.  
Crawford, J., Esq. F.G.S.  
Crosse, J., Esq.

Daubeny, C.G.B., M.D. F.R.S.  
&c.

Dechen Von, M. Henry.  
De la Beche, H. T., Esq. F.R.S.  
L. S. &c.  
Drapiez, M.  
Dulau and Co.

East India Company Directors,  
Court of.  
Editors of Phil. Mag. and Annals  
of Philosophy.

Faraday, Michael, Esq., F.R.S.  
&c.  
Featherstonhaugh, G. W., Esq.  
F.G.S.  
Ferrara, Francesco.  
Ferussac, M. le Baron de.  
Firsch, S. G., Dr.  
Fitton, W. H., M.D., President  
G.S. F.R.S. &c.  
Foster, Captain, R.N.  
Franklin, Captain, R.N.  
Frost, J., Esq. F.A.S. L.S. G.S.

Goldsmid, J. L., Esq. F.G.S.

Hammond, W. O., Esq.  
Heathfield, R. Jun., Esq. F.G.S.  
Hoeninghaus, F. G.  
Horticultural Society.  
Humboldt, Baron de, For. Mem.  
G.S.

Hutton, William, Esq.

King, Captain, P. P., R.N.

Leach, Dr.

Leeds Phil. and Literary Society.

Leonhard, M. C. C. Von.

Linnean Society.

Majendie, A., Esq. F.R.S. G.S.  
&c.

Martin, G. P., Esq.

Medico-Botanical Soc. of London.

Mitchell, Major.

Murchison, R. I., Esq. Sec. G.S.  
F.R.S. &c.

Murray, A., Esq.

Oeynhausen Von, M. Charles.

Parry, Captain, R. N.

Randolph, Rev. J. H.

Richardson, Dr.

Royal Institution.

Royal Academy of Berlin.

Royal Academy of Sciences of  
France.

Scrope, G. P., Esq. F.G.S.

Sedgwick, Rev. Adam, M. A.  
V.P. G.S. F.R.S. &c.

Sibbald, Dr.

Silliman, Benjamin, M.D. LL.D.  
Society of Arts.

Sternberg, Count.

Stift, M. gen., Superintendent of  
Mines of Nassau.

Stokes, Charles, Esq., F.R.S. &c.

Taylor, Richard Cowling, Esq.

Taylor, S.

Trevelyan, W. C., Esq.

Weiss, Prof.

Wilks, Col. Mark.

Woodward, S., Esq.

Yorkshire Phil. Society.

Zoological Society.

The Report having been read, it was Resolved,—

1. THAT the Report of the Council be approved of; and that such parts of it as the Council shall think fit, be printed and distributed among the Fellows of the Society.
2. THAT the thanks of the Society be given to John Bostock, M.D. retiring from the office of Vice-president.

The President then delivered the following Address from the chair,

#### GENTLEMEN OF THE GEOLOGICAL SOCIETY.

YOU have just received from your Council a report on the condition of your finances; with a statement of the accessions to your number during the past year, and of the measures adopted for advancing the welfare of the Institution. It remains for me to lay before you a few remarks on the branch of knowledge which the Geological Society is intended to promote: and what I shall offer upon this subject will be confined, in a great measure, to the state of Geology in this country; since neither have my opportunities of acquiring information during the past year enabled me to give, nor does my duty appear to call for, a more extended view;—though such periodical reports in



other hands, and on more suitable occasions, have been frequently attended with advantage.

We have had since our last Anniversary to regret the loss of one of our foreign members. MR. BROCCHI, whose death, according to the accounts we have received, took place in Egypt, whither he had been invited to discharge the duties of a mining Engineer, is distinguished in the recent scientific history of Italy by numerous contributions to the Geology of that country ;—and his principal work “On the Fossil Conchology of the Subapennine Hills,” abounds in valuable observations, and in proofs of accuracy and acuteness in the comparison of the fossil and existing species. His talents, however, were not merely those of an observer ;—his general views were always wide and philosophic ; and the style of his writings is considered by competent judges as remarkable for its purity and good taste. But those only, who have had the pleasure of being personally acquainted with Mr. Brocchi, could appreciate his patriotism and philanthropy, the variety of his acquirements, and the spirit and eloquence which rendered his conversation more than commonly instructive.

The printed “Proceedings” of the Society, and the portion of the Transactions published within the year, are the best records of our contributions to geological science during that period : and the volume now in progress will, I trust, be found to have contributed in no small degree to the advancement of inductive Geology. New monsters, it is true, have not been brought to light from the depths of our strata ; nor has Zoology been enriched with new genera, by such rare coincidences of genius and good fortune as distinguish the last volume of our Transactions : but the Geology of England has been illustrated by various memoirs, on tracts not previously examined ; and by more exact and extended researches on portions of our strata, the general relations of which had been before determined. Correct data have thus been recorded, to which inquirers in other countries may refer, for the purpose of comparison with their own.

I have to congratulate you upon the progress which has been made in the Trigonometrical survey of Ireland ; a work designed with all the skill of modern science, and committed for the execution to such hands, and with such instruments, as to leave no doubt of the result. Maps alone, such as this survey will produce, are an acquisition of the first importance to our inquiries ; since they form one of the chief and indispensable instruments of geological research :—but with these, in the present case, will be connected a series of observations more strictly geological, which cannot fail to throw great light

upon the structure and composition of the country to which the operations extend. The Tract, which I now show you, has been drawn up by one of the principal officers engaged in the Irish survey\*, and lithographed for the use of the subordinate surveyors; and it contains so clear and able a system of instruction for their guidance, illustrated by sectional sketches, as greatly to facilitate the task of geological investigation. The surveyors will thus accumulate a series of specimens, the precise places of which will have been recorded in maps upon a very large scale,—on which also the heights above the sea will be determined, in points almost innumerable; while sections are taken in well chosen situations, for the purpose of illustrating more effectually the order of the strata. The ultimate results of operations so well combined, must be equally honourable to those who are engaged in this vast work, and fertile in various and substantial advantage to physical science.

But while the survey of Ireland is in progress, it is to be hoped that that of England will not cease to advance; and that no great delay will take place in the publication of the maps which have been actually prepared by the Ordnance. To geologists who have travelled in England, I need not mention the benefits that our science has derived from the maps already engraved; nor dwell upon the misery of plunging, from a tract that we have traversed with the advantage of this guide, into regions where the survey leaves us, lost, as it were, and bewildered from the want of such assistance. The sheets of the Ordnance Survey which I now lay before you, represent a portion of the midland counties, coloured geologically by a gentleman whose activity and accuracy of research have made him minutely acquainted with the stratification of the district around him†; and the maps thus coloured, are probably as complete specimens of geological illustration as ever have been produced. The knowledge of this observer extends with equal precision several miles to the north of the tract here represented; but these sheets, you perceive, are bounded by a right line;—and beyond that line it has not been in his power to extend his colours, because no good map of the adjacent district is in existence. In this instance therefore, and no doubt in numberless other cases, the want of adequate maps may cause the final and irreparable loss of much geological information: And when it is considered, that Geology is but one of many departments of useful inquiry, to which good maps administer,—how much they contribute to the advancement of commerce, and to the comforts and conveniences of life,—it will

\* Captain Pringle, of the Royal Engineers.

† Mr. Lonsdale of Bath.

be unnecessary to urge the enlightened and public spirited persons, to whose hands this great undertaking is committed, to finish with as much promptitude as possible what has been so admirably begun.

The effective establishment in this country of a society for the cultivation of ZOOLOGY,—a source of just gratification to all who are interested in the progress of Natural History,—is an event connected very intimately with the advancement of our subject: for to the Geologist it is of great importance to obtain facility of access to cabinets and to living specimens, in elucidation of fossil remains; and and to have the privilege of appealing, in doubtful cases, to competent authorities, in what relates to the animal kingdom. But the connection of Zoology with our science, is a field too wide to be discussed upon the present occasion; nor would my own acquaintance with the subject justify my dwelling upon it.

The numerous provincial institutions, which have been recently established for the promotion of useful knowledge, will also materially contribute to the diffusion of a taste for Geology; and will throw new light upon the structure and productions of their respective districts.

I wish that it had been in my power to speak with equal gratification, of the relation in which our subject stands to another principal department of Natural History; but the fossil remains of the vegetable kingdom do not appear to occupy, at present, a just share of the attention of Botanists in England: and hence it has happened, that of the numerous and interesting specimens of fossil plants continually brought to light from our strata, especially within the coal districts, the greater part has been sent for illustration to those naturalists on the continent, whose publications upon this branch of inquiry, are so creditably known to science. Ought we not then to imitate the example of those, for whose labours we have so much reason to be grateful; and to reflect, that—if the botanical characters of fossil specimens be obscure, and the investigation of them at present unsatisfactory,—the subject is still comparatively new, and the difficulties such as perseverance and the multiplication of specimens must every day diminish: whilst the views to be derived from the connection of vegetable remains with geology, are scarcely inferior in interest to those already disclosed by the fossil remains of animals? The distribution of plants upon the former surfaces of the globe,—its relation to the epochs of geological deposition,—the variations it may have undergone from change of climate, either by alteration of internal temperature, or of elevation above the sea;—the former existence of vegetation in the more complex forms, in tracts

where scarcely any traces of it exist at present,—are subjects which give rise to some of the most important general questions connected with the history of the globe ;—and that require for their due consideration such an acquaintance with the characters of fossil vegetable remains, as none but the most skilful and experienced botanists can be expected to possess.

On the Geology of foreign countries, the last year has not been unproductive. A valuable paper on the structure of Jamaica, has been published in our Transactions, by one of the most skilful of our practical observers. We have received a very important contribution of specimens from Captain Franklin and Dr. Richardson, under whose direction the expedition to the northern coast of America has been conducted with so much ability and success ;—and a memoir by the latter, on the structure and components of those regions, will soon be read at one of our meetings. Captain Parry also, and Captain Foster, have presented us with a valuable collection of specimens from Spitzbergen, obtained during their late expedition to the north. Captain King, who has enriched our cabinets with specimens from the coasts of Australia, and done so much for other departments of natural history, has recently sent home a collection of rocks obtained during the earlier part of his survey in the Straits of Magellan ; and further collections, accompanied with new information, may still be expected from the same indefatigable observer. We have reason also to hope that Geology will not be neglected during the expeditions soon about to sail,—of Captain Boteler, for the survey of the western coast of Africa, and of Captain Foster, for the purpose of determining the longitude of important stations on the shores of the Atlantic.

There is the greater reason to rejoice in the contributions thus given, or to be expected, from the Naval department of the public service, since it has not unfrequently been the reproach of this country, that—possessing colonies, which have dispersed the natives of Britain in every region of the habitable globe, and commerce, that maintains continual intercourse with them,—the benefits conferred by England on the natural history of distant countries, have fallen very far short of what the intelligence and activity of our national character might have afforded. Let us hope, however, that brighter days are opening upon us ; and that those who are employed in the various departments of our foreign service, will universally feel, that where such frequent opportunities of advancing useful knowledge are likely to occur, an acquaintance with branches of science not imme-

diately essential to professional duty, is strictly accordant with the dignity of the naval and military character.

Among the donations of foreign specimens to our cabinets, there is one of very peculiar interest ;—the rich collection of fossil bones and shells presented to us by Mr. Crawfurd from Ava : which has the greater value, as it is one of the first collections of this description, that has made its way into England from our extensive empire in the East, or the adjoining territories. These specimens afford some very striking novelties, both to the Geologist and Zoologist ; an account of which, I trust, will soon be laid before you by competent describers.

The last year has produced some valuable publications on the Geology of Volcanoes, which, though not emanating immediately from this Society, are the work of our own members. We are indebted to Dr. Daubeny for a judicious volume, in which he has combined what had been previously published on volcanoes, with much valuable observation of his own. The productions of Mr. Scrope, though his speculative views are not free from objection, are full of originality and talent.—To that especially, which describes the extraordinary volcanic region in the centre of France, illustrated with such effect as to render the task of comparison with other districts easy and inviting, I should have had pleasure in alluding more fully ; if an eloquent account of it, in one of our leading journals, were not familiar to us all\* : and this, also I believe I do not err in ascribing to an active member of our Institution.

In the speculative department of Geology, nothing has been of late more remarkable, with reference to its history in this country, than the universal adoption of a modified Volcanic theory, and the complete subsidence, or almost oblivion, of the Wernerian and Neptunian hypotheses ;—so that what, but a few years since, it was by some considered as hardihood to propose in the form of conjecture, seems now to be established nearly with the evidence of fact. It is no longer denied, that volcanic power has been active during all the revolutions which the surface of the globe has undergone, and has probably been itself the cause of many of them ;—and that our continents have not merely been shaken by some mighty subterraneous force, but that strata, originally horizontal, have thus been raised, shattered, and contorted, and traversed, perhaps repeatedly, by veins of fluid matter ;—operations which have produced phænomena, so nearly resem-

\* Quarterly Review, Vol. xxxv. page 447, &c.

bling those of recent volcanic agency, that to have so long disputed the identity of their cause, is one of the most remarkable proofs in the annals of philosophic history, of the power of hypothesis in distorting or concealing truth. Whatever, therefore, be the fate of the Huttonian theory in general, it must be admitted, that many of its leading propositions have been confirmed in a manner which the inventor could not have foreseen.

The most striking modern support of these correcter views, is due to Von Buch and Humboldt, and to the facts and inferences derived by Dr. MacCulloch from the country which gave birth to Hutton, and to his illustrator, Mr. Playfair, and in which were made the experiments of Sir James Hall. More recently, a series of facts observed by Professor Henslow, in the Isle of Anglesea\*, has proved, in the most satisfactory manner, the connection of veins of trap with very high temperature; since the change produced upon the strata, through which the substances now occupying the veins were injected, has approached so nearly to fluidity, as to admit of their crystallization, in forms different from any which the components of the rocks, if they had not been thus acted on, would have afforded. Sir Humphry Davy's experiments on the fluids contained within cavities in crystals †, are another striking and unexpected confirmation of Hutton's views: and our own Transactions, besides various incidental pieces of evidence derived from this country, supply the testimony of an unprejudiced witness to an earthquake on the coast of Chili‡, which brings almost before the eyes of the reader, the movement and permanent elevation of the land.

Having alluded to Mr. Playfair's support of the volcanic theory, it would be unjust to the memory of that distinguished man, not to mention, that his geological writings have had, indirectly, an effect in accelerating the progress of our subject, the benefit of which we experience at this moment, and probably shall long continue to feel; and which, perhaps, outweighs in value the partial success of the speculations for which he so strenuously contended. He clothed our subject with the dignity of an eloquence most happily adapted to philosophic inquiry; and redeemed the geologist from association with that class of naturalists who lose sight of general laws, and are occupied incessantly with details,—placing him, where he ought to stand, beside the mathematician, the astronomer, and the chemist; and permanently raising our science into an elevated department of inductive inquiry. His mild and tolerant character threw an assuaging influence upon the waves of a controversy, which in his

\* Transactions of the Cambridge Philosophical Society. vol. i. page 406.

† Philosophical Transactions, 1822, page 367, &c.

‡ Geological Transactions, second series, vol. i. page 413.

time considerations, entirely foreign to science, had exasperated into unusual violence : and if, fortunately, there is no longer any trace of this asperity, the change must, in a great degree, be ascribed to the tone of Mr. Playfair's writings, enforced by the manly and consistent tenour of his blameless life.

I cannot, for your sake, regret that the presence of some of those who have had a large share in the foundation of this Institution, prohibits my alluding to their continued and unremitting efforts in support of it.—And the same cause prevents my dwelling on the effects produced, at both our Universities, by the geological instructions delivered there ; which have given to the subject an impulse perhaps without example in the history of those institutions, and gone far to render natural science a permanent department of general education.

But there is one of our number, whom professional and domestic occupations retain so much in a remote quarter of the country, that we have seldom the gratification of his presence amongst us, though his writings are in all our hands : and it is a duty,—not to Mr. Conybeare, but to the subject, and to ourselves,—to say, that among the more recent causes which have accelerated the progress of Geology in England, the publication of the “*Outlines of England and Wales*,” by him and Mr. Phillips, has had an effect, to which nothing since the institution of this Society, and the diffusion of the geological maps of England, can be compared. It is with peculiar pleasure that this statement can be made in this place ; since a large proportion of that work has been derived from our own Transactions, and the authors have long been distinguished members of our Society. Of course their publication is not free from defects and inequalities,—inseparable perhaps from a first edition, composed for the greater part during its progress through the press:—but, regarding it as the first general sketch of a country so complex as our own, it may be said without fear of contradiction, that no equal portion of the earth's surface has ever been more ably illustrated ;—nor any geological work produced, which bears more strongly impressed upon it the stamp of original talent for natural science.

The object, however, of our Institution, to adopt the language of the charter, is “*to investigate the mineral structure of the EARTH* ;”—not to confine ourselves to the British Islands only, (and even they are best illustrated by comparison,) but to extend our researches if possible, to every part of the globe ;—to record the geological phenomena of the most distant countries, as well as of our own,—and from the whole, derive the laws that have regulated the structure of this

planet, and still influence the changes which are in progress upon it. It is our good fortune, and the fact is intimately connected with the commercial wealth of our country, that it affords perhaps a greater variety of strata and of geological appearances, than most other portions of the civilized world of such limited extent ; while the range and variety of our coasts unveil the geological anatomy of England, with an obviousness and convincing facility to the observer, that have greatly accelerated our inquiries. The Geology of England, therefore,—which, with a view only to commercial advantage, and to the comforts and conveniences of life, would have well deserved all the labour that has been bestowed upon it,—acquires a new and more dignified interest, when we reflect that this island is in a great measure an epitome of the globe ; and that the observer, who makes himself familiar with our strata, and the fossil remains which they include, has not only prepared himself for similar inquiries in other quarters, but is already, as it were, acquainted by anticipation with what he must expect to find there. If, therefore, I were called upon to state in what manner those who have leisure, health, and talent for such inquiries, can most effectually advance the bounds of our science, and increase the reputation which England has begun to acquire in this department of natural knowledge,—I should say, that it would be,—First, by rendering themselves accurately familiar with the geological phenomena of our own country ; and then,—by taking abroad with them the knowledge thus acquired, and comparing the phenomena with those of distant regions ; since it is only from the multiplication of such comparisons, that sound general views can be derived.

But even within the British Islands, there still are tracts, and of no small extent, which are comparatively, and a great part of them absolutely, unknown. More than one half of Ireland is in this condition : for the publications of Conybeare and Buckland, Stephens, Weaver, Griffith, and Dr. Berger, comprehend nearly all that has been done in that country. But this subject, as I have already mentioned, has passed into such hands, as will, no doubt, accomplish every thing that can be desired.

In the North and North-west of England, the labours of Otley\*, Smith, Professor Sedgwick, and some other inquirers, have already ascertained the principal relations of one of the most important dis-

\* The work here referred to, is a brief but valuable notice, "On the succession of rocks in the district of the Lakes," published in the *Lonsdale Magazine*, or *Provincial Repository*, for October 1820 :—Vol. I. No. x. pp. 433, &c.



tracts; but very little has yet been published upon it. And on the mountainous tracts in Wales, the ancient and very interesting essay of Owen \*, and the valuable papers of Mr. Aikin and Professor Henslow, with that of Mr. De la Beche on Pembrokeshire, and of Mr. Martin on the Coal Basin of Glamorganshire †,—a tract on which Mr. Conybeare is occupied at present,—comprehend nearly every thing that deserves to be mentioned here.

In Scotland also, notwithstanding the graphic and copious illustrations of Dr. MacCulloch, and the mineralogical skill and perseverance of other eminent naturalists who have applied themselves to the Geology of their native country,—no geological map has yet appeared; and a great part of that rich and varied region remains to be explored. But the Society will have pleasure in observing, in the last portion of their Transactions ‡, that an effective comparison of the more recent strata of Scotland with our English formations has been already begun. The memoir of Mr. Murchison on the Brora Coal-field is an excellent specimen of what may be effected in this department of inquiry; and a paper produced at the last meeting by the joint labours of Professor Sedgwick and Mr. Murchison, leaves no doubt that the remaining memoirs which are to be expected from those gentlemen, will throw great light on the comparative geology of that distant portion of our island.

The value, however, of the researches and identification at Brora, goes much further than the mere comparison of a remote tract, with the stratification of England: they confirm a suggestion of Dr. Buckland and Mr. Lyell, that the coal formation of that neighbourhood was in reality the equivalent of a portion of our Oolitic strata; and demonstrate the remarkable fact, that the same fossils which in England occur in oolitic limestone, exist there in strata of quartzose sandstone and of shale! The whole series indeed, of the phenomena developed by recent examination in Scotland and the north of England, gives rise to the most interesting speculations on the questions of geological identity, and of the relative value in geology of mineralogical and zoological characters,—which has been so ably treated by Brongniart and other continental writers:—questions, which it is necessary to keep continually in view, and that acquire fresh interest and importance in proportion as we extend our researches to the remoter districts of the world.

To those amongst us who are confined to England, the most use-

\* Dated in 1570;—See Cambrian Register, for 1796, and Geol. Trans. N. S. Vol. I. page 312.

† Philosophical Transactions, 1806: page 342.

‡ Second Series, vol. ii. p. 293.

ful task perhaps would be, when we have mastered the general relations of our series, to take up some one portion of the subject,—a group of strata, or even a single stratum, or any one of the numberless questions connected with their zoological and mineralogical relations,—and to publish in the form of *Monographs* the results of our inquiries. For it may be stated with confidence, that there is not any one of our strata, however familiarly it may be supposed to be already known, that would not, if thus treated, reward the most elaborate and minute examination.

But those who are deprived of the privilege of travelling even in England, must not suppose that they can be of no service as geologists; or if they belong to our body, that they are thus released from their obligation to be active in our cause: and there are two descriptions of persons,—the resident clergy, and members of the medical profession in the country,—to whom what I am about to say may be more particularly deserving of attention. Such persons, if they have not yet acquired a taste for natural science, can hardly conceive the interest which the face of the country in their vicinity would gain, however unpromising it may appear, by their having such inquiries before them; how much the monotony of life in a remote or thinly inhabited district would thus be relieved; nor how much benefit they might confer on the natural history of their country. Even of those who have made some progress in geological studies, many, I apprehend, are prevented from investigating attentively the tracts where they reside, or from communicating their knowledge, by a belief that the Geology of England itself is sufficiently known already; and that the district, with the phenomena of which they are themselves familiar, would have no interest or novelty for the world at large:—whereas it may be asserted (and it were easy to produce examples from modern researches in some of the counties near London), that there is no district that will not furnish sufficient interest and novelty to an attentive inquirer, not merely to repay his own exertions, but to instruct the most learned, and enlarge the bounds of our science.

To landed proprietors also, it can hardly be known, without some tinge of geological information, how nearly our subject is connected with Agriculture,—with an acquaintance with the nature and correctives of the soil, the supply of water, and facility of effectual drainage, and numberless facts essential to the perfection of rural œconomy;—with the discovery and supply of stone, for building and the construction of roads,—the choice of the line of roads and of canals, and the facility of their execution. All these are but a few of the topics that

come strictly within the province of the geologist: and which are so essential to the prosperous management of landed property, that a geological map may perhaps with truth be considered as not less necessary to the country gentleman, than the topographical plan of his estates.

I am fully aware, that much of what I have just said is obvious;—and even familiar, to the greater part of those who hear me:—But my object is to be useful; and I believe that some of those whom these remarks are likely to reach, are not sufficiently acquainted with the practical advantages derivable from our pursuits;—and that others are unconscious of the means within their own power for advancing them.

I shall conclude, Gentlemen, by congratulating you on the good feeling by which the proceedings of this Society have always been characterized; and on the self-command that renders both agreeable and instructive the conversations, (I will not call them discussions—much less debates) with which it is now our practice to follow up the reading of memoirs at our table; and which have given to our evening meetings a character more like that of social intercourse in a private circle, than of the formal proceedings of a public body. This practice, I know, has been a subject of doubt, to many who wish well to our institution, and do not undervalue the personal character and disposition of our members. But, so long as our conversations are carried on with the urbanity by which they have hitherto been distinguished,—while it is the wish of those who share in them to give or to receive information, and not to shine,—and the object is not victory but truth,—there seems to be no reason to apprehend any very serious injury from the continuance of our geological warfare.

There is still another train of thought connected with our meetings, on which I confess I have sometimes delighted to dwell. The spirit in which they have been conducted has been so kind,—so little tainted with, or rather so perfectly free from, any admixture of the leaven with which from interest or ambition most of the pursuits of life are embittered;—and our duties here have been associated with so many offices of cordiality and friendship;—that when, in after life, the cares and chances of the world may have dispersed those whom I have now the happiness to see around me, I am fond to believe that the remembrance of these evenings will be called to mind with pleasure:—And I feel confident, that, as many of us already derive the chief part of our enjoyments from the friendships to which congenial pursuits have led, the Geological Society will continue to

be no less effective, in the production of warm personal attachment, and of manly and ingenuous intercourse among its members, than it has been, in maintaining an active and energetic spirit of research.

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The Meeting then proceeded to the election of the Council and Officers for the ensuing year; when the following list was delivered in by the Scrutineers :—viz.

*President.*

William Henry Fitton, M.D. F.R.S. &c.

*Vice-Presidents.*

Arthur Aikin, Esq. F.L.S.

Rev. W. Buckland, D.D. F.R.S. &c. Professor of Mineralogy and Geology in the University of Oxford.

Charles Lyell, Esq. F.R.S. &c.

Rev. A. Sedgwick, F.R.S. &c. Woodwardian Professor, Cambridge.

*Secretaries.*

W. J. Broderip, Esq. F.R.S. &c.

R. I. Murchison, Esq. F.R.S. &c.

*Foreign Secretary.*

Henry Heuland, Esq.

*Treasurer.*

John Taylor, Esq. F.R.S.

*Council.*

J. E. Bicheno, Esq. F.R.S. Sec. L.S.

John Bostock, M.D. F.R.S.

Rev. W. D. Conybeare, F.R.S. &c.

John Crawford, Esq. F.R.S.

Michael Faraday, Esq. F.R.S. &c.

Davies Gilbert, Esq. M.P. Pres. R.S.

G. B. Greenough, Esq. F.R.S.

J. F. W. Herschel, Esq. F.R.S. Pres. A.S.

Leonard Horner, Esq. F.R.S. &c.

Ashurst Majendie, Esq. F.R.S.

Rev. J. H. Randolph, M.A.

N. A. Vigors, Esq. F.R.S. Sec. Z.S.

Sir R. R. Vyvyan, Bart. M.P.

Henry Warburton, Esq. M.P. F.R.S. &c.

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# PROCEEDINGS

OF

## THE GEOLOGICAL SOCIETY OF LONDON.

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1827—1828.

No. 7.

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March 7.—A Paper was read “On the Geological Relations and Internal Structure of the Magnesian Limestone, and the lower portions of the New Red Sandstone series, in their range through Nottinghamshire, Derbyshire, Yorkshire, and Durham.”—By the Rev. A. Sedgwick, M.A. V.P.G.S. F.R.S. &c.

A sketch of the subjects contained in this paper was laid before the Society in 1826 (Nov. 17) :—They were resumed in a more systematic and detailed form during two meetings in 1827 ; and are now terminated by the observations read at the present meeting,

The contents of the Memoir are presented in the following order :

PART I.—§ 1. *Introduction*.—The new red sandstone is considered as one great complex formation, interposed between the coal measures and the lias ;—with two calcareous formations subordinate to it, one in the lower part of the series (the *magnesian limestone*), and another in the upper part (the *muschel-kalkstein*). The lower of the two calcareous formations is considered in detail ; the upper has not yet been discovered among the British secondary deposits.

§ 2. *External characters of the country through which the Magnesian Limestone ranges*.—The form of the western escarpment is described, and is supposed to exhibit proofs of great denudations ; and the general character of the soils resting upon the formation is noticed.

§ 3. *General distribution of the formation*.—The range of the escarpment is given in great detail ; some errors of the geological maps are corrected ; and in describing the eastern boundary, the enormous masses of diluvium in the county of Durham are briefly noticed.

§ 4. *Outliers*.—Sixteen outliers from the western escarpment are described ; the most southern of which is at Conisborough. In addition to these, there are eight detached patches of magnesian limestone on the line of bearing, which are not considered as outliers. The most remarkable of these are seen in the range through Yorkshire.

§ 5. *Relations of the Magnesian Limestone to a succession of Coal Measures*.—In a general point of view these formations must be unconformable, because the overlying beds are extended far beyond the limits of the productive parts of the carboniferous order : and the fact is also proved by actual sections in several parts of Yorkshire and Durham. At the same time there are continuous tracts of country where the want of conformity does not appear, and where the over-

lying beds seem almost to graduate into the coal measures. Several details are given respecting ancient coal works, in which, in more than one hundred places, the coal had been extracted by *shafts sunk through the magnesian limestone*: and it is asserted that the quality of the coal is never injured by the presence of the overlying formations. Such injury is not only contrary to fact, but seems to be a physical impossibility.

§ 6. *On the Faults affecting the Magnesian Limestone and Coal strata, Trap dykes, &c.*—Examples are given of some great faults which traverse both the carboniferous and the superior formations: but it is remarked that many of the dislocations of the lower order of rocks do not affect the upper. Respecting the age of the trap dykes of the coal-fields, it is not possible to determine their epoch in comparison with that of the magnesian limestone, where they range up to the escarpment:—and of such dykes there are only two examples; one of which does, and the other does not, pass through the beds of the overlying series.

PART II.—*Internal Structure and great Subdivisions of the Magnesian Limestone.*—Considered as a subordinate part of the new-red-sandstone series, this formation admits of five natural subdivisions, each of which is described in a separate section:

§ 1. *Lower Red-sandstone, or Rothe-todte-liegende.*—In Yorkshire this appears generally in the form of a coarse siliceous sandstone, of a reddish tinge. It is associated with incoherent sand, red micaceous shale, and sometimes with variegated marls. In Durham it is generally represented by a yellowish and nearly incoherent sand. In some places it cannot be distinguished from the gritstone beds of the coal measures: but as it commences in the edge of Derbyshire, and is almost co-extensive with the magnesian limestone as far as the mouth of the Tyne, it must on the whole be unconformable to the inferior order. It is, however, of very unequal thickness, and its upper beds are not always parallel to the strata of limestone which rest upon it. In Durham, being of loose texture and pervious to water, it throws the greatest difficulties in the way of mining operations carried on within the limits of the limestone.

§ 2. (a). *Variegated Marls, with irregular Beds of Compact and of Shell Limestone.*—This deposit is not either of great extent or thickness, and is confined to a small part of the escarpment in Nottinghamshire and Derbyshire. It is supposed to be contemporaneous with the following subdivision:

(b). *Marl-slate, and Compact Limestone.*—This is much more extensively developed than the preceding formation; and though by no means co-extensive with the yellow limestone, derives importance from its constancy of position and from its fossils. Several localities in the county of Durham are described; and among the beds of marl-slate of East Thicky, &c., two or three species of fern have been discovered; and seven or eight species of fish, four of which at least seem to be identical with fish of the *Copper-slate*.

§ 3. *Great central deposit of Yellow Limestone.*—It is subdivided into the following modifications, each of which is described in detail.

(1) *Dolomite*, a simple crystalline rock.—(a) Arenaceous dolomite, coarse, nearly incoherent, often in minute rhombs.—(b) Small-grained dolomite. Many quarries of this variety are described as existing on the back of the deposit, and extending from the neighbourhood of Mansfield to Bramham Moor. The crystalline beds pass into others of mechanical structure, and in some extreme cases contain 20 or 30 per cent of siliceous sand.—(2) *Compact magnesian limestone*.—(3) *Laminated*.—(4) *Earthy*.—(5) *Masses of irregular concretionary structure*.—(6) *Beds or concretionary masses of crystalline limestone without magnesia*. Examples of these are derived from quarries near Ripon, Knaresborough, and Newton Kyme, &c.—(7) *Brecciated structure*. This modification abounds on the coast of Durham.—(8) *Small concretionary structure*.—(a) Irregular.—(b) Regular or oolitic.—(9) *Large globular concretionary structure*.—Of this, four principal modifications are described with minute detail. All these several subdivisions of structure are supposed to have been produced by great internal movements, after the mechanical deposition of the formation.

§ 4. *Lower Red Marl and Gypsum*.—This extends from the edge of Nottinghamshire to the banks of the Wharf; thins off at the two extremities; attains its greatest thickness (perhaps nearly 100 feet) on the right bank of the Ais;—but has not been discovered in Durham or the northern parts of Yorkshire.

§ 5. *Upper thin-bedded Gray Limestone*.—Near Ferry Bridge this contains very little magnesia. In other places it contains subordinate dolomitic beds. It commences at Carlton near Worksop, and ranges without interruption to the left bank of the Wharf. Further north it reappears in several places, under a modified form: and the highest beds on the coast of Durham may perhaps be referred to it; but the classifications are made obscure by the absence of the *lower red marl*.

§ 6. *Great Subdivisions of the new red Sandstone which are superior to the dolomitic series*.—In Nottinghamshire these consist of two principal deposits.—(a) Upper red sandstone.—(b) Upper red marl and gypsum.—The same subdivisions may be traced near the mouth of the Tees. In the central parts of Yorkshire they are obscured by diluvium.

By way of conclusion,—the deposits described in § 1 and § 2, are supposed to be the equivalents of the *rothe-todte-liegende*, the *kupferschiefer*, and *zechstein*.—Those described in §§ 3, 4, and 5, are in like manner supposed to be the equivalents of the *rauchwacke*, *asche*, foliated *stinkstein*, breccias, and gypsum, which compose the upper part of the Thuringerwald system. The coincidence, in order, mineralogical character, and organic remains, seems to be nearly perfect. In like manner the two divisions described in § 6, are taken as the respective equivalents of the *bunter sandstein* and *keuper*; and, the enormously thick deposits between the coal measures and the lias, with the exception of the *muschel-kalkstein*, are thus found to admit of the same natural subdivisions in England and in central Germany. Finally, the author speculates about the origin of the do-

lomit deposits, and adopts in part the theory which derives them from the mechanical destruction of the rocks of the carboniferous order. He states however two facts, which seem to imply that the waters of the ocean had a power of separating carbonate of magnesia from the pre-existing rocks, in a manner which is not explained by the mere mechanical hypothesis:—1st, the greater abundance of magnesia than could have been supplied by the dolomites of the carboniferous limestone; 2ndly, the fact that some beds contain a greater proportion of magnesia than is found in true dolomites.—Whatever may have been the origin of the whole system; its extent, regular subdivisions, and characteristic organic remains, seem to prove, that it originated in the long continued and consistent operation of powerful causes, acting simultaneously in distant parts of the earth.

March 21.—Benjamin Silliman, M.D. LL.D. of Yale College, North America, was elected a Foreign Member of this Society. Francis Finch, Esq. and Thomas Winter, Esq., both of West Bromwich, Staffordshire, were elected Fellows of this Society.

A Paper was read, entitled “Topographical and Geological Notices, from information collected during the Expedition to the North-west coast of America under the command of Captain Franklin; by John Richardson, M.D. F.R.S., &c.”

The expedition under Captain Franklin having arrived at their intended winter quarters on the shore of Great Bear Lake, examined in 1825 the vicinity of that lake, and the course of the Mackenzie River from thence to the sea. The author subsequently accompanied Captain Franklin down the river, as far as Point Separation, in lat.  $67^{\circ} 38'$ ; from whence the latter proceeded westward to lat.  $70^{\circ} 26'$ , long.  $148^{\circ} 52'$ :—the extreme western point seen by the expedition being in long.  $149^{\circ} 37'$  west. Dr. Richardson at the same time went eastward to the mouth of the Copper Mine River, and thence returned overland and across the Great Bear Lake, to the headquarters.

This Paper contains an account of the specimens collected, and the geological observations made by both divisions of the party; and gives in considerable detail a description of the vicinity of Great Bear Lake, with a more general one of the banks of the Mackenzie and of the coast to the East of it; to which are subjoined some observations respecting the country previously passed over by the expedition, between Lake Superior and Fort Franklin. The distances traversed being, in latitude, about 23 degrees N. of Lake Superior; and in longitude, altogether about 80 degrees;—60 degrees to the west of Lake Superior, and 20 degrees on the coast, eastward from the mouth of the Mackenzie. The total extent passed over in America by the expedition, in going and returning, was about 14,000 miles; and that surveyed and laid down for the first time on the maps, is about 5000 miles.

The author however mentions, that a very limited portion of his time could be devoted to geological researches; the ground being for



eight months in the year covered with snow ; and the other objects of the journey demanding his principal attention during the short summer.

The country described consists, in general, of three or four formations, or series of beds, which occupy well marked divisions :—

1. The most western division comprehends the Rocky Mountains, which appear to be composed of primitive rocks ; and the course of the ranges is from about S.E. to N.W. ; the faces of the hills to the eastward being abrupt, but the slope towards the W. more gradual. These mountains join the sea on the west of the Mackenzie ; and at their termination are divided into four groups or chains, to which Captain Franklin has given the names of *Richardson's*, *Buckland's*, the *British*, and *Romanzoff* chains. The land again becomes lower to the west of the chain last mentioned, and continues to be so from thence to the remotest point arrived at ; no prominent elevations having been observed to the west of long. 146°.

2. Another very extensive tract of primitive rocks in the north of America has nearly the same direction with the range of the Rocky Mountains, but the two ranges converge towards the north ; the distance between them being, in lat. 50°, 700 miles ;—about 220 miles where it was traversed by Captain Franklin, in going from Hudson's Bay to Lake Winipeg ;—and in lat. 66° only 200 miles. This eastern primitive tract consists principally of granite and gneiss ; it exhibits great uniformity of character, contains no very elevated ground, and is in fact traversed by several rivers which arise in the Rocky Mountains. It is flanked on both sides by extensive calcareous tracts.

3. The north-eastern extremity of the Rocky Mountain chain, near the mouth of the Mackenzie, consists of grauwacke and other transition-rocks, interposed apparently between the primary and the calcareous districts. In some of the other places described, a rock resembling the old-red-sandstone of England, occupies a similar situation.

4. The tract that intervenes between the Rocky Mountains and the eastern primary band above mentioned, consists principally of calcareous strata, and is remarkable from its including, throughout, a series of great lakes or lake-like rivers, with which a very large proportion of the surface is occupied, and the bottoms of which appear in several instances to be below the level of the sea. This intermediate calcareous band was traced in one place by the author, to the width of about 280 miles from the eastern primary tract ; and one of its highest summits, about a mile from Bear Lake, was supposed to be about 950 feet above the sea. The limestone of which this district is composed, as well as that of the calcareous tract on the east of the primary band above mentioned, presents considerable uniformity of character : the ridges of hills are nearly parallel to those of the Rocky Mountains ; and a very large proportion of the rocks observed by the author, was found to be magnesian limestone,—apparently belonging either to the magnesian limestone formation of England, or to our mountain-limestone, which it is well known includes in Europe numerous beds of dolomite.

The fossils also of this calcareous formation, are of the same genera with those of our mountain-limestone and of the magnesian beds in the north of England ; including corallines, productæ, terebratulites, and a cardium : and in several places the calcareous beds contain a large proportion of chert and flinty slate. The correct determination of the relations of this great calcareous tract, is one of the chief points of interest remaining for future research, in the country described by the author ; for while he agrees with other geologists in assigning a portion of it, (as in the vicinity of Lake Winnipeg,) to the mountain-limestone of Europe, he justly remarks that in other places the quantity of gypsum, in connection with copious salt springs, and great abundance of petroleum, together with the occurrence of soft marly-sandstone, and beds of breccia interstratified with those of dolomite, and above all, the fact that dolomitic limestone is by far the most common and extensive rock in the deposit, would lead to its identification with the zechstein of continental geologists,—the magnesian limestone of the North of England.

5. Above the limestones, and in some cases, it would appear, alternating with the dolomite, is a very extensive deposition of sandstone, bituminous-shale, and slaty-clay (which last exhibits in some places the peculiar structure denominated cone-in-cone) containing nodular ranges of clay-iron-stone and beds of lignite. The shales include impressions of ferns, lepidodendrons, and other vegetable remains ; and among the fossils of this formation was also found an ammonite, supposed by Mr. Sowerby to belong to a part of the oolitic series of England. It deserves inquiry therefore, whether this may not be the equivalent of the carboniferous strata which form a portion of the oolitic series in Yorkshire, and at Brora in Scotland.

The series of beds above described occurs extensively in the course of the Mackenzie River, and on the shores of the Great Bear Lake ; and from its being found also on the northern coast, at a distance of about 300 miles from thence, and in a direction precisely corresponding, it not improbably occupies the intervening country.

About Cape Bathurst (lat.  $70^{\circ} 36'$ , long.  $127^{\circ} 35'$ ) cliffs of alum shale form the coast for more than 60 geographical miles, and are described as resembling those of Whitby in Yorkshire.

6. On the promontory of Cape Lyon are extensive ridges of columnar trap associated with limestone and slate-clay ; and greenstone is of frequent occurrence there and in some other places. Porphyry also, forms low conical hills in the high ground between the Copper Mountains and Bear Lake.

7. Near the western boundary of the limestone, and not far from the base of the Rocky Mountains, there occur at intervals, from lat.  $50^{\circ}$  to  $69^{\circ}$  N. extensive (*tertiary* ?) deposits, consisting generally of sandstone, gravel, clay more or less bituminous, and brown wood-coal. In some spots the wood-coal was replaced by an excellent pitch-coal, the fractured surface of which is marked with very peculiar concentric semicircular depressions ; and it is interesting to know that this coal, which would be excellent fuel for a steam-vessel, occurs

on the coast of the Polar sea near the Mackenzie in considerable quantity. This formation contains layers of a variety of pipe-clay which is eaten by the natives, and is said to sustain life for a considerable time. The deposit at the mouth of Bear Lake River includes some beds of impure porcelain earth. The author found occasionally much difficulty in distinguishing the sandstones and shales of this deposit, from those of the formation mentioned above in Section 5.

8. Among the indications of other strata more recent than the magnesian limestone, was a loose fragment of soft limestone found at the mouth of Babbage River, on the coast west of the Mackenzie, containing the species of *Cyclas* (*C. medius*) which occurs extensively in the weald-clay of England.

This memoir, which will be published in full in the Appendix to Captain Franklin's Narrative of the expedition, is illustrated by maps and drawings, and accompanied by a catalogue in detail, of the specimens referred to, which have been presented to the Geological Society.

April 18.—William Hutton, Esq. of Newcastle-upon-Tyne, Beriah Botfield, Esq. of Christchurch Oxford, and William Parker Hamond, Esq. of St. John's College Cambridge, were elected Fellows of this Society.

A Paper was read, "On the fossil remains of two new species of *Mastodon*, and of other vertebrated animals, found on the left bank of the Irawadi; by William Clift, Esq. F.G.S. F.R.S., conservator of the Museum of the Royal College of Surgeons."

The author having been requested to describe the fossil remains which the zeal and liberality of Mr. Crawford have transferred from the deserts of the Irawadi to the Museum of the Geological Society, confines himself strictly to zoological and anatomical details; and following the system of Cuvier, commences with the

*Pachydermata proboscidea*.—The only genus of this order indicated by the remains is the *Mastodon*; and of this there are two species, *Mastodon latidens* and *Mastodon elephantoides*, not only commanding attention from their novelty, but from the beautiful gradation which they exhibit between the mastodons already described and the elephant. On comparing the teeth of *Mastodon latidens* with those of the mastodon of the Ohio (*M. giganteum*) the denticles are found to be more numerous, and less distant, and the interstices less deep than in those of the latter. The teeth, in short, begin to assume the appearance of those of the elephant. On advancing to *Mastodon elephantoides*, these features of similarity are more strongly developed: the many-pointed denticles are still more numerous and more compressed; and the structure, were it not for the absence of *custa petrosa*, becomes almost that of the tooth of the elephant. In both, though the teeth are formed upon the principle by which the tooth of the mastodon is distinguished from that of the elephant, the crown of the tooth wears away more like that of the elephant than that of the other mastodons:

The species are thus characterized :

*Mastodon latidens*.—*Mastodon dentibus molaribus latissimis, denticulis rotundatis, elevatis. Palato valdè angusto.*

The dentition very much resembles that of the elephant. The molar tooth is gradually pushed forward, and rises as the fangs are added, according to the demand occasioned by the abrasion of the exposed crown, and the consequent absorption of the anterior fang ; the posterior part of the tooth not having yet cut the gum, while the anterior portion is completely worn away. Before it are seen the relics of the preceding tooth, the place of which the tooth in use was progressively supplying.

The lower jaw in this species is less square and deeper than it is in *M. giganteum*.

The tusks, judging from the alveoli, must have been of equal volume with those of the largest living elephant.

The following is the measurement of some of the remains of *M. latidens*.

Extreme breadth of fragment of cranium (upper jaw with the greatest part of both grinders) .....	1 Ft. 3 In.
Length of ditto .....	1 8
Extreme length of right anterior grinder (6 denticuli and the spur) .....	0 8 $\frac{1}{4}$
Extreme breadth at third denticulus .....	0 4
Circumference of lower jaw, measured over the grinding surface of the tooth .....	2 4
Extreme length of tooth .....	0 1 $\frac{3}{4}$
Extreme breadth .....	0 4 $\frac{1}{2}$
Circumference of the lower extremity of right femur	2 2
Same, round the condyles .....	2 4

*Mastodon elephantoides*.—*M. dentibus latis ; denticulis numerosis, compressis.*

This species must have been smaller than the last. There is a fine example of the lower jaw, showing the tooth in the highest degree of perfection. The tooth is 11 inches long and 3 $\frac{1}{2}$  inches broad has no less than ten denticles, and each of these denticles is mamilated with small points ; five being the smallest, and eight the greatest number on any one denticule. In front of this tooth is seen the remnant of the preceding one, worn down and disappearing ; and behind it is the cavity wherein the young tooth, intended as a successor to that in existence, was in the course of formation. The denticles are much more compressed than those in the species last described ; they are closer together, and the whole tooth approaches still more nearly to that of the elephant, while the jaw is in unison with the appearance of the tooth.

*Pachydermata ordinaria*.—In this group we have the remains of the genera *Sus*, *Hippopotamus*, and *Rhinoceros*. Of the first there is only a single specimen, consisting of a small portion of the lower jaw, containing one molar tooth and the fragment of another. Of the second there are but few fragments, nor are they sufficiently characteristic to warrant a definition of the species, which must have been

comparatively small. Of the third there is a portion of the upper jaw, containing two molar teeth; and portions of the lower jaw with molares, which seem to approach nearer to those of the rhinoceros of Java than to those of any other living species.

*Ruminantia*.—In this group we have fragments of the ox and of the deer.

#### REPTILIA.

*Chelonia*, Cuv.—(*Testudinata*, Bell).—There are many fragments of a large species of trionyx, and some of an emys. But the remains are not sufficiently defined for specific description.

*Sauria*.—Fam. *Crocodylidae*.—Of this family we have the remains of two genera; viz. a *Leptorhynchus* allied to, if not identical with, the great gavial; and a crocodile resembling *Crocodylus vulgaris*. Of the former there are portions of the lower jaw and several vertebrae; of the latter, there is the anterior termination of the lower jaw, which must have belonged to a very large individual.

The specimens, in general, do not appear to have undergone any mineral change, with the exception of being abundantly penetrated with iron, and are very brittle. This last circumstance, arising from the loss of their animal gluten, indicates great antiquity, and that they have not been imbedded in any very compact soil; unlike the teeth of the mastodon of the Ohio, which lie in a strong blue clay, and have almost as much animal matter as is to be found in a recent tooth.

The bones are almost in every instance broken; and from the firmness of texture of most of them, the direction and cleanness of the fracture, and the sharpness of its edges, the injury, which must have been the result of an immense power operating with sudden violence, appears to have taken place at the period, or very soon after the period, of the destruction of the animal.

A Paper was next read "On a collection of vegetable and animal remains, and rocks, from the Burmese Country, presented to the Geological Society by J. Crawfurd, Esq," by the Rev. W. Buckland, D.D. V.P.G.S. F.R.S. &c.

Mr. Crawfurd collected these specimens during his voyage up the Irawadi in a steam-boat, on an embassy to Ava, in the latter part of the year 1826. The author considers them to be of high importance, as affording an answer to the curious, and till now undecided question, whether there be, or be not, in the southern regions of Asia, any remains of fossil quadrupeds analogous to those which are found so widely dispersed in the diluvium of northern Asia, and of Europe and America.

The evidence which Mr. Crawfurd has imported, consists of several chests full of fossil wood and fossil bones, and of specimens of the strata that are found along the course of the Irawadi, from Prome up to Ava, being a distance of nearly 500 miles. The greater part of the fossil wood is beautifully silicified; other specimens of it are calcareous; they are mostly portions of large trees, both monocotyledonous and dicotyledonous, and were found along the whole valley of the Irawadi from Ava to Prome. The bones were all collected from

a small district near some wells of petroleum, about half way between these towns, and on the left bank of the river. From Mr. Clift's examination, it appears, that although we have among them no remains of fossil elephants, we have the same fossil pachydermata that are found associated with elephants in Europe; namely, rhinoceros, hippopotamus, mastodon, and hog. We have also two or three species of ruminantia resembling the ox, antelope and deer, with the addition of the gavial and alligator, and two freshwater tortoises, namely, trionyx and emys.

The teeth of the mastodon belong to two unknown species of that genus, both of them approaching in size to the largest elephant. Mr. Clift has designated them by the names of *Mastodon latidens* and *M. elephantoides*. The teeth are from animals of all ages; and there are many fragments of ivory, derived probably also from the mastodon.

The remains of the mastodon are by far the most abundant in this collection, and amount to about 150 fragments.

Of the rhinoceros there are about 10 fragments.

Of a small species of hippopotamus, 2.

Of the hog, 1; and of the ox, deer and antelope, about 20.

Of the gavial and alligator, about 50.

Of the emys, 20; and trionyx, 10.

One fragment of emys is so large, that the animal of which it formed a part, must have been several feet in width.

The state of preservation of these bones is very perfect, from their being penetrated with hydrate of iron, and thereby rendered strong. Not one of them is silicified, though they have been erroneously stated to be so, in some of the periodical journals.

The district in which they were found is a little North of the town of Wetmasut, and is composed of barren sand-hills and beds of gravel intersected by ravines, and cemented occasionally into a breccia by carbonate of lime, and sometimes by hydrate of iron. Over the surface of these hills were scattered the fragments of bones and wood, some quite naked and loose, others half buried in the sand and gravel. Many fragments of wood lay also at the bottom of the ravines. About one-third of the bones have been slightly rolled; and the rest had all been broken before they were lodged in the places where Mr. Crawford found them, and where they appear to have been dispersed and buried, by the action of the same waters that produced the diluvial sand and gravel, whence they have since been washed out, and left bare by the action of rains and torrents.

Concretions of sand and gravel adhere to many of the bones, but they contain no traces of shells, and differ mineralogically from all the rock specimens in this collection, which we recognize as belonging to tertiary and freshwater strata.

Indications of freshwater formation were found in one spot only, not far from the fossil bones, and they consist of a marly blue clay, abounding with shells of a large and thick species of *Cyrena*.

The tertiary rocks are: 1st, a dark slaty limestone, containing

many shells, that have been identified by Mr. Sowerby with those of the London clay. 2nd, a yellow sandy limestone containing shells, and resembling the *calcaire grossier*, and 3rd, a soft greenish sandstone resembling the sandy beds of our plastic clay formation.

This London clay and *calcaire grossier* afford an additional locality of these strata to those indicated by the specimens described by Mr. Colebrooke, in vol. i. Part 1, 2nd series of the Geological Transactions, —which had already established the existence of this formation in the N.E. border of Bengal.

Mr. Crawford states distinctly, that it is impossible to refer the situation of the bones, or the origin of the hills containing them, to any operations of the existing river: these hills are sixty feet above the level of its highest flood; the effect of its actual operations, he observes also, is distinctly visible in the shifting islands of mud and sand that abound along the whole course of the river within this high-flood level, and in the great alluvial delta that extends from a little below Prome to Rangoon and the gulf of Martaban.

The recent bones and recent wood which he observed to be stranded on some of these islands, were not in a state of progress towards becoming mineralized, but were falling rapidly to decay.

The existence of so many animal remains analogous to those that occur in the diluvium of Europe, in a matrix which so nearly resembles that diluvium, and which so decidedly differs from the alluvium, and freshwater, and tertiary strata of the adjacent country, seems to authorize us to refer this matrix to a similar diluvial deposit in the valley of the Irawadi, reposing irregularly upon the tertiary and other stratified rocks, that form the basis of that district.

Besides the tertiary strata above enumerated, there are specimens of grauwacke and transition-limestone from several distant points in the valley of the Irawadi between Prome and Ava, which render it probable that the fundamental rocks of this valley belong to the transition series.

On the north of Ava there are chains of primitive mountains abounding with statuary marble, associated, as usual, with hornblende and mica slate.

We may therefore consider it as now established, on the authority of Mr. Crawford's notes and specimens, that the Burmese country not only contains the remains of fossil animals above enumerated, but also affords examples of the following geological formations, which can be identified with those of Europe; namely—

1. Alluvium.
2. Diluvium.
3. Freshwater Marl.
4. London Clay and *Calcaire grossier*.
5. Plastic Clay, with its sands and gravel.
6. Transition limestone and grauwacke.
7. Primitive marble and mica slate.

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On the same evening, after the ordinary business of the Society

had been transacted, a special general meeting was held, when the President having stated, that the Lords Commissioners of his Majesty's Treasury had been pleased to transfer to this Society some of the apartments in Somerset House, formerly used as the Lottery Office, and lately in the possession of the Royal Society; and that a sum not less than 1000*l.* would be required for preparing the said apartments for the reception of the Society, and the removal of their Library and Collections:—

It was resolved unanimously,

I. On the motion of Davies Gilbert, Esq. M.P., Pres. R.S., seconded by Henry Warburton, Esq., M.P.,—That the thanks of this Society be given to the Right Honourable the Lords Commissioners of his Majesty's Treasury, for the grant which they have been pleased to make to this Society, of apartments in Somerset House.

II. On the motion of the Rev. Dr. Buckland, Professor of Geology at Oxford, seconded by the Rev. A. Sedgwick, Woodwardian Professor at Cambridge,—That the thanks of this Society be given to Davies Gilbert, Esq. the President, and to the Council of the Royal Society, for their aid and cooperation in obtaining from the Lords of his Majesty's Treasury a grant of the apartments in Somerset House.

III. On the motion of Robert Ferguson, Esq., seconded by Leonard Horner, Esq.,—That a Subscription be immediately entered upon, to defray the expense of the necessary repairs in the apartments recently granted to the Society in Somerset House, and of the removal thereto.

May 2.—At a special general meeting holden this day at one o'clock, for the purpose of electing a Member of the Council in the room of Ashhurst Majendie, Esq.; and also for electing a Secretary in the room of R. I. Murchison, Esq., and a Foreign Secretary in the room of Henry Heuland, Esq., who had retired from their respective offices;

It was resolved unanimously,

I. That the thanks of this Society be given to Ashhurst Majendie, Esq., retiring from the Council.

II. That the thanks of this Society be given to Henry Heuland, Esq., for his long services in the office of Foreign Secretary, and for the high regard which he has always manifested for the welfare of the Society.

III. That the thanks of this Society be presented to R. I. Murchison, Esq. on his retiring from the office of Secretary.

A ballot having been held for electing a Member of Council in the room of Ashhurst Majendie, Esq., the scrutineers reported that Dr. Henry Burton was duly elected.

A ballot having been held for electing a Secretary in the room of R. I. Murchison, Esq., and a Foreign Secretary in the room of Henry Heuland, Esq., the scrutineers reported that Dr. Burton was elected Secretary; and that R. I. Murchison, Esq., was elected Foreign Secretary.



At the Ordinary Meeting holden on the same evening, John Claudius Loudon, Esq., of Porchester Terrace, Bayswater; and Thomas Copeland, Esq., of Golden Square, were elected Fellows of this Society.

An extract of a letter was read from Lieutenant William Glennie, R.N., dated Mexico, May 6th, 1827, entitled "The Ascent of Popocatepetl."

Many contradictory reports having long existed respecting the volcanic nature of this mountain, the author felt desirous of ascertaining its actual condition in person.

The ascent commenced during the month of April 1827, from the village of Ameca, situated in the province of Puebla, and near the N.W. foot of the volcano, at an elevation of 8216 feet above the level of the sea, and distant 14 leagues from Mexico.

The author describes the sides of the mountain as thickly wooded with forests of pines, extending to the height of near 12,693 feet, beyond which altitude vegetation ceased entirely. The ground consisted of loose black sand of considerable depth, on which numerous fragments of basalt and pumice-stone were dispersed. At a greater elevation, several projecting ridges, composed of loose fragments of basalt, arranged one above another, and overhanging precipices 600 or 700 feet deep, presented formidable impediments to the author's progress; and, in one direction only, a ravine was observed to pass through these ridges, having its surface covered with loose black sand, down which fragments of rocks ejected from the crater continually descended.

After twelve hours of incessant fatigue the author gained the highest point of the mountain on the western side of the crater, 17,884 feet above the sea; at which station the mercury in the barometer subsided to 15·63 inches, and the temperature indicated by the attached and detached thermometers, was respectively 39° and 33° Fahr. at 5 o'clock P.M., when exposed to the direct rays of the sun. The plain of Mexico was enveloped in a thick haze, and the only distant objects visible at that time, were the volcanoes of Orizaba and Iztacihuatl. The crater of Popocatepetl appeared to extend one mile in diameter, and its edges of unequal thickness descended towards the east. The interior walls consisted of masses of rock arranged perpendicularly, and marked by numerous vertical channels, in many places filled with black sand. Four horizontal circles of rock differently coloured were also noticed within the crater; and from the edges of the latter, as well as from its perpendicular walls, several small columns of vapour arose smelling strongly of sulphur. The noise was incessant, resembling that heard at a short distance from the sea shore during a storm; and at intervals of two or three minutes the sound increased, followed by an eruption of stones of various dimensions; the smaller were projected into the ravine before mentioned, the larger fell again within the crater.

The sensations experienced by the author were analogous to those usually felt by travellers at considerable elevations; viz. weariness, difficult respiration, and headache, the latter inconvenience having

been first perceived at a height of 16,895 feet. Tobacco smoke and spirituous liquors were also found to produce an unusually rapid effect upon the sensorium.

At the same meeting a letter was read from J. B. Pentland, Esq., addressed to W. H. Fitton, M.D. P.G.S., respecting the fossil remains of some animals from the N.E. border of Bengal.

The author has discovered among the mutilated fragments of bones obtained from the tertiary deposits on the Bramahpootra River in the small state of Cooch-Behar,—presented to the Society some years ago, by David Scott, Esq., and referred to in a former volume of the Transactions\*,—the remains of four distinct species of mammalia, making an interesting addition to the list already published by Mr. Colebrooke; viz.—

1. A species of the genus *Anthracotherium* of Cuvier, which the author proposes to distinguish by the name of *A. Silistrense*,—a specific denomination derived from one of the many names by which the great Bramahpootra river appears to have been designated by ancient geographers.

2. A small species of the order Ruminantia allied to the genus *Moschus*.

3. A small species of herbivorous animal referable to the *Pachydermata*, but more diminutive than any of the fossil or living species of that family at present known.

4. A carnivorous animal of the genus *Viverra*.

\* Geol. Trans. 2nd Series. vol. i. p. 135.

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# PROCEEDINGS

OF

## THE GEOLOGICAL SOCIETY OF LONDON.

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1827—1828.

No. 8.

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May 16.—Decimus Burton, Esq. of Spring Gardens ; and Major T. Perronet Thompson, of the 65th Regiment, were elected Fellows of this Society.

The reading was begun of a Paper entitled, “ On the Old Conglomerates, and other secondary deposits on the north coasts of Scotland ;” by the Rev. Adam Sedgwick, Woodwardian Professor, Cambridge, V.P.G.S. &c. and R. I. Murchison, Esq. For. Sec. G.S. and F.R.S.

June 6.—M. H. Ducrotay de Blainville, Member of the Institute of France, and of many other learned and scientific Societies, was elected a Foreign Member of this Society ; and Richard Taylor, Esq. Sec. L.S. of Middleton Square ; Charles Larkin Francis, Esq. of Nine Elms, Surrey ; and Jeffry Wyattville, Esq. R.A. of Lower Brook Street,—were elected Fellows of this Society.

The reading of the Paper of Professor Sedgwick, and R. I. Murchison, Esq., begun at the last Meeting, was concluded.

§ 1. *Introduction*.—The authors here give a brief sketch of the general structure of Scotland, to the north of the Forth and the Clyde. They consider the country to be composed of two entirely distinct classes of deposits—primary and secondary ; but with the primary deposits are associated many mountain masses of crystalline rock, which appear to have been protruded since the deposition of the newest of the secondary series ; and hence arises great, and sometimes insuperable, difficulty, in passing from one class of deposits to the other. The lowest of the secondary strata are chiefly composed of red-sandstone and red-conglomerate : and from a general review of this part of the subject, the authors conclude, that the conglomerate system on the N.E. coast of the Highlands is identical with that on the N.W. coast ; and that both the systems are of the same epoch with the great masses of conglomerate which commence at Stonehaven, and range along the southern flank of the Grampian chain.

§ 2. *Range of the old-red-conglomerates through Caithness, and on the shores of the Murray Firth, &c.*—These rocks are stated to appear in several unconnected masses on the north coast, between Cape Wrath and Port Skerry ; and from the latter place they range into the interior, and rise into a mountain chain (the highest parts reaching the elevation of 3500 feet), which is continued to the granite of the Ord of Caithness. Their range parallel to the shores of the Murray Firth, is also given with many details. They are stated to be deve-

loped upon an enormous scale, and sometimes to form two distinct chains of broken mountains, resting unconformably upon the primary strata. On the south-eastern shores of the Murray Firth they gradually thin off; and finally disappear near Cullen bay, in Banffshire.

§ 3. *On the general structure of Caithness.*—After an account of the external appearance of the county, the authors describe in great detail two coast sections. The first, commencing with the old conglomerates of Port Skerry, which rest immediately upon the granite, exhibits the successive deposits in ascending order, and terminates with the newer red-sandstone on the shores of the Pentland Firth. The second section exhibited on the east coast, commences with the newer red-sandstone, and passing through all the intermediate deposits, finally exposes the old conglomerate system in a part of the coast between Borridale and the Ord. From a general review of the phenomena exhibited in these two sections, as well as from other details derived from the interior of the county, the authors conclude that the secondary deposits may be divided into three great natural groups :—

1. The old conglomerates,—which contain some subordinate masses of red-sandstone, red marle, and calcareo-siliceous flagstone; and which, through the intervention of the red-sandstone, sometimes graduate into the next system.

2. A great formation, occupying all the lower regions of the county, and composed of alternating beds of sandstone, siliceous and calcareo-siliceous schist and flagstone, dark foliated bituminous limestone, pyritous shale, &c.; the siliceous beds giving the type to the lower part of the formation, and the calcareo-bituminous beds to the intermediate part. This formation again becomes more siliceous and arenaceous in the upper portion, and so appears to graduate into the next superior division.

3. A great formation of red, brown, and variegated sandstone, which composes lofty precipices on the south shores of the Pentland Firth. It reappears on the other side of the Firth in the lofty red cliffs of the Orkneys, and there also reposes upon a calcareo-bituminous schist.

§ 4. *Fossil fish of the secondary deposits of Caithness, &c.*—These seem to be contained almost exclusively in the calcareo-bituminous schist, which is subordinate to the middle group of § 3. They do not appear to be confined to any particular part of it, but were found in various localities, some in the lowest and others in the highest part of the series; and in many places scales and imperfect impressions exist in the greatest abundance. Some imperfect specimens were examined during a preceding year by the Baron Cuvier, who found that they all exhibited a pointed tail (with the rays exclusively on the lower side,—as in the fish of the copper-slate of Thuringia), and notwithstanding the great imperfection of the specimens, he concluded that they were of the order *Malacopterygii abdominales*, and analogous to the bony pike. Since that time much more perfect specimens have been procured, which have been examined by Mr. Pentland; who has not only been enabled to confirm the conjectures of Baron Cuvier, but has ascertained two new genera, each containing two species.

The first genus (*Dipterus*) has a double dorsal fin, and the other fins are nearly in the same position as in the *Esocii*.—One of the species (*Dipterus macrolepidon*) is remarkable for the size of its scales, which sometimes exceed half an inch in diameter. The second genus is nearly allied to *Amia* and *Lepisosteus*. The body is covered with hard quadrangular scales, disposed in oblique rows. In all the species the peculiar formation of the tail, before alluded to, is the same.

Along with the fish were found the remains of a *Testudo*, nearly allied to *Trionyx*, and one specimen of a vegetable impression: but not a single fossil shell or zoophyte has yet been discovered in any part of the county. It adds to the interest of this singular assemblage of organic remains, that they all resemble the inhabitants of fresh water.

§ 5. *Secondary deposits on the shores of the Murray Firth*.—Several transverse sections through these deposits are described in great detail; and from a comparative view of the phænomena exhibited in a section from the conglomerate mountains in East Ross to the north Sutor of Cromarty, and from thence to Tarbet Ness, it appears that these secondary deposits admit of three natural divisions, like those described in Caithness. The conglomerates in both counties are the same. The formations in the lower region of East Ross contain subordinate beds of calcareo-bituminous schist; and though fossils are much more rare than in Caithness, yet a few examples of fish-scales, and a fragment of a *Testudo* resembling a *Trionyx*, have been found between the north Sutor and Tarbet Ness.—Lastly, the highest beds of the whole series near Tarbet Ness, may be compared with the newer red-sandstone of the Pentland Firth.

The transverse sections exhibited near the south shores of the Murray Firth, differ considerably in their details from what has been described. The bituminous schists seem to be in some measure replaced by beds of concretionary limestone, resembling the cornstone of Herefordshire: and these beds are surmounted by a great formation of white sandstone, nearly resembling the sandstone associated with the coal measures between the old and new-red-conglomerates in the Isle of Arran.

§ 6. *Red-sandstone and conglomerate series on the N.W. coast of Sutherland and Ross-shire*.—These extend almost without interruption from Cape Wrath to Applecross; and the authors (after stating a few facts in addition to the details already given by Dr. MacCulloch) assert that, through the intervention of the patches of conglomerate on the north coast of Scotland, they are most intimately connected with the conglomerates which extend from Port Skerry to the Ord of Caithness. The two systems appear also to be identical in their general character and relations. There are some difficulties arising out of the peculiar modifications of the quartz-rock, which sometimes cannot be distinguished, mineralogically, from that of the unconformable red-sandstone and conglomerate series. The authors have, however, no hesitation in classing the great red-sandstone series, which extends from Applecross to Cape Wrath, with the older portions of the secondary deposits of Caithness and Sutherland.

§ 7. *Conclusion.*—The deposits previously described are here compared with the corresponding formations of England.—1. The old-red-conglomerates are, from their mineralogical character and position, identified with the old-red-sandstone of English geologists.—2. The great central deposit, containing the ichthyolites, does not appear to be perfectly identical with any formation hitherto described. It seems in some measure to occupy the place of the coal formation. Many parts of it resemble grauwacke in mineralogical character; and from its enormous development, it can hardly be compared with the copper-slate of Germany. Again, none of the fish of Caithness are identical with the fish of the copper-slate. The upper part of the Caithness schist might however, in accordance with the Arran section, be compared with the copper-slate; in which case the red-sandstone of the Pentland Firth might be considered as the representative of the new-red-sandstone of England. There is however a break in the series, and it is perhaps impossible to determine where the interruption takes place.—3. The red-sandstone on the shores of the Pentland Firth most nearly resembles the red-sandstone of Arran, which is interposed between the coal measures and the conglomerates of the new-red-sandstone.

A Paper was read by the Rev. Dr. Buckland, on the *Cycadeoideæ*, a new family of fossil plants, specimens of which occur silicified in the Free-stone quarries of the Isle of Portland.

These fossils have as yet been noticed only in the Isle of Portland; their existence has long been known to many persons, and to the author, who acknowledges the assistance of Mr. Brown and Mr. Lodiges, in assigning to them their place in the vegetable kingdom, where they stand near the living Genera *Zamia* and *Cycas*.

Their external form approaches to that of the fruit of a pine-apple, and is still more like the trunk of a living *Zamia*, varying from five to fifteen inches in height, and from eight to fifteen inches in width. The stems are nearly cylindrical, and terminate downwards in a broad flat bottom, without any indication of roots: they have no true bark, but are inclosed in a thick case, composed of the permanent bases of decayed leaves, having a structure like that of the bases of the leaves of the recent *Zamia*; they are terminated externally by lozenge-shaped impressions, or scars, of which a continuous series winds spirally, like the scales on a fir cone, round the whole exterior of the plant.

As yet no leaves have been found adherent to any of these fossils, but at the upper end there is a cavity, from which the crown and last leaves appear to have been removed, before the petrification of the stems.

The author describes and gives engravings of two species of these fossils, with comparative sections of the recent *Zamia* and *Cycas*.

1. In the larger species, which he calls *Cycadeoidea megalophylla*, the bases of the leaves are two inches long, and have nearly the form and size of those of the *Zamia horrida*. The trunk is short, and has a deep central cavity, like the interior of a bird's nest,—in which a number of siliceous plates intersect one another, and form an irre-

gular plexus, unlike any vegetable structure, but resembling the coarse cellular appearance that is common in fossil wood. Nearer the circumference there appear distinct organic radiations, disposed in an insulated circle,—like that in the trunk of a recent *Zamia*, but differing, in that it is much broader, and placed nearer the circumference of the stem. The larger plates of this circle are made up of smaller plates, almost invisible to the naked eye. Between this radiating circle and the outer case or leaf stalks, is a narrow band, composed of a minutely cellular, and nearly amorphous substance, but analogous in structure and position to a much broader band that is exterior to the radiating circle of the recent *Zamia*.

2. In the second and smaller species (*Cycadeoidea microphylla*), the bases of the leaves are about an inch in length, but small and numerous, much like those of the *Xanthorrhoea*, or Gum Plant, of New South Wales. The trunk is more elongated, and the cavity at the summit less deep, whilst the transverse section exhibits the same irregular net-work at the centre, but near the circumference has two concentric circles composed of radiating plates; and exterior to each of these a narrow ring devoid of plates,—analogous to the two laminated circles within two cellular circles in a recent *Cycas*.

In external and internal structure, these plants approach more closely to the existing family of *Cycadeæ* than to any other; and they supply, from the fossil world, a link to fill the distant void which separates the *Cycadeæ* from the nearest existing family, the *Coniferæ*. Their occurrence in the Portland oolite adds another to the many facts which indicate the climate of these regions, during the period of the oolitic formations, to have been similar to that of our tropics.

A letter to the President was read, from Gideon Mantell, Esq. F.G.S. &c. enclosing a list of the fossils of the county of Sussex.

This list, which is taken principally from specimens in the author's own collection, enumerates the fossils, first, of the alluvial and diluvial deposits; and, successively, those of the London clay, the plastic clay, chalk, chalk-marle, firestone, gault, Shanklin sand, and Hastings deposits, including the Ashburnham beds.

Subjoined is a comparative table; one of the most remarkable features of which, is the preponderance of the number of species in the marine formations over those of the beds assumed to be of fresh-water origin, in a ratio of not less than six to one; the testaceous mollusca forming two-thirds of the whole, while in the fresh-water strata, the proportion is reversed. Thus the marine deposits contain upwards of two hundred and forty species of shells, and the two fresh-water formations but twenty-two species. In the other classes and orders, equally striking differences are observable.

On the other hand the marine formations are destitute of the characteristic fossils of the fresh-water formations, viz. birds, terrestrial and fresh-water reptiles, shells and vegetables. The author, in short, concludes that a comparison of the living inhabitants of our lakes and rivers, with those of the ocean, would not offer more striking discrepancies.

June 20.—John, Earl of Shrewsbury, of Great Stanhope Street, May Fair, and of Alton Abbey, Staffordshire ; Robert Allan, Esq. of Charlotte Square, Edinburgh ; W. S. Henwood, Esq. of Perran Wharf, Truro, Cornwall ; and the Rev. John Ward, Vicar of Great Bedwin, Wilts,— were elected Fellows of this Society.

A Paper was read “ On the Geology of Bundelcund, Boghelcund, and the districts of Saugor and Jabalpoor in central India.” By Captain James Franklin, of the Bengal Army, F.R.S. F.A.S.

The tract of country described by the author is a portion of the lowest northern steps of the Vindáya mountains, situated between the latitudes  $22^{\circ} 40''$ , and  $25^{\circ} 20''$  N., and the longitudes  $78^{\circ} 30''$ , and  $83^{\circ}$  E. ; having on its north-eastern extremity the towns of Mirzapoor and Allahabad, and near its southern limit, those of Tendukaira, Singpoor and Mundla.

In this extent of country the principal situations examined by Captain Franklin were, the pass of Tara in the first range of hills ; the pass of Kattrá in the second range ; the cataracts of Billohi, Bauti, Kenti, Chachye, and of the Tonse river ; the neighbourhood of the villages of Simmereah, Hathee, Birsingpur, Sohawel, Nagound, and Lohargaon ; the bed of the Cané river near Tigra ; the neighbourhood of Hatta, Narsing-hagarh, Patteriya, Saugor, Tendukaira ; the valley of the Nermada river ; Garha-kota, Great Deori ; the Bandair and Kymur hills ; Jabalpoor, and the waterfall of Beragurh.

The succession of formations observed by the author consisted, in a descending order :—1. Of diluvial deposits.—2. Of overlying rocks of the trap formation.—3. Of a compact limestone.—4. Of red-sandstone.—And, lastly, 5. Of primitive rocks, including granite, gneiss, &c. The Paper is illustrated by a geological map and section of the country ; and the author particularly wishes to direct the attention of geologists to the limestone of the second range of hills, which he is of opinion corresponds with the lias-limestone of England, a formation which has not hitherto been shown to exist in India.

Having commenced his route at Mirzapoor on the Ganges,—in a district covered with alluvium reposing in some places on beds of “Canker,” in others on sandstone, the author ascended the first range of hills at the pass of Tara. These hills are composed of fine-grained sandstone horizontally stratified, and more or less coloured by red oxide of iron ; the rock appears to be saliferous, and is in many places quarried for architectural purposes ; and it seems to correspond with the central portion of the new-red-sandstone of England.

At the pass of Kattrá, near the summit of the second range of hills, a friable variegated sandstone appears, in which thin laminæ of sandstone alternate with red clay, resembling the red marle of England, both reposing on slaty marle coloured by chlorite, which rests, apparently, on massive horizontal strata, resembling clay-slate or grauwacke.

At the bottom of the cataract of Billohi, 398 feet in height, argillaceous sandstone was found, tinged deeply by red oxide of iron, and



containing disseminated mica,—on which reposed a siliceous sandstone of a more compact texture.

Greenish white arenaceous sandstone not quite so compact was found at the cataract of Bauti, 420 feet below the summit, varying in colour as it ascended : and twenty-four miles further westward, at the cataract of Kenti, and at a depth of 272 feet, as well as at the cataracts of Chachye and of the Tonse river, sandstone of the same general character was observed rising to the surface.

The sandstone of Simmereah is sometimes ferruginous, at others slaty, and interspersed with mica ; in the neighbourhood of Hathee it is succeeded by what the author considers as the equivalent of the lias-limestone.

At Birsingpur, in the bed of a small river, is a stratum of red marle or sandstone, containing laminæ of calc-spar ; at Sohawel the red marle underlies the limestone above mentioned ; and at Nagound in the bed of the Omeron river, the lower and central beds of limestone are exposed to view, containing fragments of fossil wood, stems of ferns,—and, as the author states, the gryphite which is characteristic of this formation in Europe.

This limestone appears also at Hatta and Narsinghagarh reposing on red marle, and in the latter situation is tinged green by chlorite. At Patteriya, where the limestone comes into contact with trap, the strata assume in some places the form of chert.

The aspect of this limestone is dull and earthy ; its stratification horizontal or nearly so, and always conformable to the red marle on which it reposes.

Between the pass of Patteriya and Saugor, the author met with no other rock than trap, generally in the form of boulders imbedded in friable wacken, and composed of concentric layers : beneath the boulders is a bed of indurated wacken and basalt ; and under the latter a stratum of impure limestone, in some parts containing a large proportion of alumine ; below the limestone is a stratum of amygdaloid, containing calc-spar and a few zeolites, which at Saugor reposes on sandstone.

The trap of Saugor continues without interruption to Tendukaira : it contains abundance of chalcedony, semiopal, mealy zeolite, cachalong, agates, jaspers and heliotrope.

At about the distance of three miles from the foot of the hills near Tendukaira, in the valley of the Nermada river, the older rocks are exposed to view, in strata which are highly inclined,—in some instances nearly vertical, and in all cases unconformable to those already noticed.

On his route from Tendukaira to Garha-Kota, captain Franklin was enabled to ascertain the eastern boundary of the trap formation, which is throughout intimately associated with earthy limestone ; the whole series reposing on red marle and sandstone.

Trap in horizontal strata was also observed for an extent of three miles near Great Deori, previous to the appearance of the sandstone of the Bandair hills, which last-mentioned rock the author is of opinion

corresponds with the new-red-sandstone of England; the same chain of hills is composed of sandstone opposite Nagound, Lohargaon, Tigra, and Gurreha. The Kymur range in some parts appears to be composed of quartz-rock, varying to siliceous grit, in strata nearly vertical; but to the S.W. near Hirapur, the rock becomes more compact; and still further west, opposite Googni, it is intermixed with clay-slate and schistose limestone.

A broad valley covered with diluvium, intervenes between the Kymur range of hills and Jabalpoor; and near that town another range is situated, composed of granite containing flesh-coloured felspar, smoky quartz, black mica and hornblende;—and in which, also almost every rock commonly associated with granite is to be found.

Snow-white dolomite, traversed occasionally by chlorite schist, is to be seen near the waterfall of Beragurh, intimately associated with quartz; it is here capable of taking a fine polish, and scarcely effervesces with acids; but a few miles further west, near Bograi, it is exceedingly friable, and effervesces freely: it moreover contains crystals of Tremolite.

Captain Franklin observes that a part of the southern barrier of the valley of the Nermada river, like the northern barrier opposite Tendukaira, is composed of trap-rocks, the contour of which, to the extent of 80 miles, he has laid down on his map. The eastern deposit of overlying rocks extends southwards as far as Chuparah, and thence eastward towards Mandela, Omercuntuc, and Sohagpoor; but whether it is united with the great central mass, he was unable to ascertain.

The Paper concludes with some inferences from the observations; and after stating the opinion of the late Dr. Voysey, that “the basis of the whole peninsula of India is granite,” (*Asiatic Researches*, Vol. XV. page 123.) the author observes,—1. That although granite is very near the surface in many parts of the tract which fell under his examination, yet there is here, as in other countries, a series of primary stratified rocks intervening between the granite and secondary formations; which series however, there is reason to conclude, is thin and often wanting.

2. The sandstone formation has a visible thickness of 420 feet at the cataract of Bouti, and is considerably thicker no doubt near Chachye and the Bandair hills, &c. The limestone formation on the contrary, which in other countries sometimes forms mountain tracts, and occupies extensive portions of the earth’s surface, is in India a mere plastering, as it were, over the red marle or sandstone; and Captain Franklin doubts whether it ever attains a thickness of 100 feet; 50 feet being perhaps a fair average. He never met with it in any other situation than on the summit of the second range of hills.

3. The overlying trap-rocks are not only the most extensive, but, considering them in a geological view, the most important formation in this part of India. The thickness of this formation is variable: it reposes on every rock indiscriminately, from granite upwards; and at Saugor it may be seen on sandstone, where its inferior boundary is

about 1350 feet above the sea. In the centre of India it occupies the summits of the highest mountains; and at Bombay it descends to the level of the sea.

There are two kinds of basaltic rock in the district of Jabalpoor, clearly of distinct formations; the older variety penetrates the grauwacke stratum, in the bed of Nermada river, near Lamaita; the younger is an overlying rock like that at Saugor,—but reposing on granite, and containing a greater proportion of augite and olivine.

Captain Franklin also describes a calcareous conglomerate, found in the beds of most of the rivers whose sources or channels are in the trap, and of sufficient cohesion for architectural purposes: its stratification is always horizontal, and in point of age he thinks it must be classed with the tufas and concretionary formations so prevalent in India.

An appendix to this Paper contains the results of barometrical and thermometrical observations made between Nov. 1826, and Feb. 1827, on the route from Mirzapoor to Saugor, and thence to Tendukaira and Jabalpoor; with the heights of fifty-four places above the sea, and the latitudes and longitudes of the respective stations.

An extract was read of a letter from Samuel Hobson, Esq. to Dr. Roget, F.G.S. Sec. R.S. &c. (dated at New Orleans, 6th April, 1827,) and enclosing an account of some gigantic bones,—by Samuel W. Logan, M.D.

The place where these bones had been found is not mentioned; but at the date of the letter, they were exhibited publicly at New Orleans. Dr. Logan describes them as consisting of one of the bones of the cranium, fifteen or twenty vertebræ, two entire ribs and a part of a third, one thigh-bone, two bones of the leg, and several large masses of a cancellated structure.

*The cranial bone* was twenty feet and some inches in its greatest length, about four feet in extreme width (for the bone tapers to a point), and it weighed twelve hundred pounds. Dr. Logan inclines to think that this is the temporal bone.

*The vertebræ*, consisting of a body, oblique transverse, and spinous processes, gave sixteen inches as the mean diameter, and twelve inches as the depth of the bodies; while the passage for the spinal cord measured nine inches by six. The spinous processes stand off backwards and downwards, fourteen inches in the dorsal, and somewhat less in the lumbar vertebræ, three of which latter are entire.

*The ribs*, well formed and in a perfect state of preservation, measured nine feet along the curve, and about three inches in thickness.

*The thigh-bone*, measured in length, gave only one foot six inches, but is very thick. The bones of the leg are of similar dimensions, but perhaps a little more slender.

It had been conjectured that the animal to which these remains belonged, was amphibious, and perhaps of the crocodile family; and the conjecture appeared to Dr. Logan to be justified by the great length and flatness of the head (judging from the single specimen of the cranial bone), and the shortness of the limbs. It was also sup-

posed that the animal, when alive, must have measured five and twenty feet around the body, and about one hundred and thirty feet in length.

An Extract was read of a letter from his Grace the Duke of Buckingham, to Professor Buckland, V.P.G.S. dated at Naples, 3rd April, 1828, giving an account of certain phænomena, which attended the late eruption of Vesuvius. The author states that the Solfaterra was in no degree affected by the eruption.

A Letter was read from Charles Stokes, Esq. F.G.S. F.R.S. to W. J. Broderip, Esq. Sec. G.S. explanatory of three drawings of Echini, representing,—1. A specimen of *Galeorites albo-galerus* (Lam.), from the chalk, in which the plates of the mouth, consisting of five pairs, are preserved *in situ*;—2. A *Cidaris*, also from the chalk, in which portions of the plates of the mouth and the teeth are visible: they are displaced, but exhibit a system quite analogous to that of the recent *cidaris*;—and, 3. A *Cidaris* from Stonesfield, in which the anal plates are in the best preservation.

At the close of this Meeting, which terminated the Session, the Society adjourned till Friday Evening, the 7th of November; when they will meet at their Apartments in Somerset House.

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PROCEEDINGS  
OF  
THE GEOLOGICAL SOCIETY OF LONDON.

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1828—1829.

No. 9.

November 7.—The Society having assembled this evening for the session :—

The reading of a Paper “On the Geology of Nice,” by H. T. De la Beche, Esq. F.R.S. L.S. & G.S. was begun.

Nov. 21.—The reading of Mr. De la Beche’s Paper “On the Geology of Nice” was concluded.

The author, after describing the situation of Nice, enters into a detailed account of the diluvium and the strata in its neighbourhood.

I.—The diluvium (if indeed it can be so considered) is peculiar ; in general it takes the form of breccia, either diffused irregularly or occupying clefts : appearing however in both situations to be intimately connected.

1. Most of the diffused fragments correspond mineralogically with the rocks on which they rest ; some few are rounded, and seem to have been transported from a distance. The cement varies in hardness and colour with the substratum. Where the breccia reposes on dolomite or light-coloured limestone, it is so hard as to be blasted by gunpowder, is reddish and vesicular ; the vesicles being lined with calcareous crystals.—Where it rests upon gray secondary limestone, or on any of the tertiary beds, it is soft, friable, and almost white. Between Ville-franche and Hospice, the substratum is a sand, full of shells so like those of the Mediterranean as to have been called *sub-fossil* : some of these shells retain traces of their native colour ; the rest are bleached. This sand-bed at Ville-franche is ten feet at least above the sea : at Baussi Raussi, where it descends to that level, the breccia exhibits pebbles of serpentine as well as limestone :—the limestone pebbles being perforated by lithodomi, and the cement containing sub-fossil shells. None of these breccias contain bones.

2. The other variety of the diluvium is lodged in fissures. A vein on the south-east of the Castle Hill has its northern side perforated by lithodomi, and yields two different kinds of pebbles,—in the blue limestone of the lower part, and the magnesian above. This spot, therefore, affords evidence of four distinct epochs.—1. When the sea, higher than at present, introduced lithodomi into the fissure.—2. When the lower part of the fissure was filled with pebbles transported from a distance.—3. When its upper part was filled with the broken bones of animals, shells terrestrial and marine, and with fragments, principally but not solely, of contiguous rocks.—4. When the sea attained its present level.

3. The fossils under the breccia seem to have been quietly deposited by a sea that stood several feet higher than the present Mediterranean. To explain this difficulty, some authors imagine that the Mediterranean has sunk, by forcing its passage through the Straits of Gibraltar; but this supposition the author conceives to be improbable.

II. 1.—Tertiary rocks consisting of sand, sandstone, and a conglomerate of various rolled pebbles, shell marl, calcareous gritstone and breccia, and gray marl, occupy an extensive area on the west and north-west of Nice.

The shell marl here mentioned is that which Brocchi has described; and it contains, in the Sub-Alps, the same fossils as in the Sub-Appennines.

In the calcareous breccia are angular pieces of the contiguous limestone and dolomite perforated by lithodomi; adhering to which are sometimes found the lower valves of spondyli, quite perfect, notwithstanding the delicate texture of their edges. The cement contains three species of pecten;—with remains, perhaps, of a Saurian. Care must be taken not to confound this latter breccia, which rises more than a thousand feet above the sea, with the diluvial breccia above described.

On reviewing the tertiary beds, the author remarks in their probable history three distinct epochs; viz. two of repose, and one of violent disturbance.

2. The Secondary rocks of Nice consist of two great formations; the upper one composed of siliceous, argillaceous, and calcareous particles intimately mixed, but in very variable proportions; some of the beds abounding in green grains; which circumstance, together with the nature of their fossils, induces the author to rank the formation to which they belong with the green-sand of England. Nummulites, however, which are rarely found in the green-sand of this country, are found plentifully in that of Nice. The strata are very much disturbed and contorted; so that an unguarded observer might often suppose them to be inferior to rocks on which they are in reality incumbent.

The green-sand is succeeded by a lower formation, which the author refers to the Jura-limestone or oolite. In this he has found, occasionally, terebratulæ; in addition to which, Mr. Allan states that it contains ammonites, pectens, an echinus, and, near the lighthouse at St. Hospice, numerous corals. In mineralogical character, this stratum is very unlike the English rocks which it is supposed to represent; its principal members being compact limestone, with occasionally, flint, dolomite, and gypsum. The dolomite and compact limestone are intimately connected; but the connection of these two beds with the gypsum is less evident. At Sospello the gypsum affords numerous small crystals of carbonate of magnesia or dolomite; but both these substances are found in too many formations to be considered as characteristic.

The strata to which the compact limestone, dolomite and gypsum of Nice are most analogous, are those of the Tyrol, Carinthia, Stiria,

and the North of Italy; in regard to the history of which, M. Von Buch has supposed that what is now dolomite, was in the first instance ordinary limestone; the magnesia which they contain at present having been absorbed from pyroxenic lava, by the forcible intrusion of which both this and the contiguous rocks were elevated, dislocated and contorted. The author assents to this theory; and as the phenomena of the tract described by M. Von Buch agree with those of the vicinity of Nice, he ascribes the interchange of magnesian and non-magnesian limestones, and the violent disturbances which both have undergone in the latter instance, to the same cause which M. Von Buch adduces, viz. the proximity of pyroxenic lava. Trap-rocks, however, have not been observed very near Nice: but there may be such, he conceives, within a short distance in depth; and the probability that there are, is strengthened by the prevalence of rocks of this class in the mountains of S. Troper and l'Estrelles, and by the frequency of pebbles both of trap and porphyry in the tertiary conglomerates above described.

The occurrence of dolomite and gypsum in what the author considers as the oolite formation, and the impracticability of recognizing in this formation near Nice any of the individual beds of which it is composed in England, are new proofs of the danger of judging of large tracts of country, by rules derived from the study of detached specimens.—The same stratum, in different parts of Europe, assumes very different appearances; and extreme nicety of discrimination injudiciously applied, is more apt to mislead the geologist than to instruct him.

Dec. 5.—The reading was begun, of a Paper “On the Excavation of Valleys, as illustrated by the Volcanic rocks of Central France,” by Charles Lyell, Esq. V.P. G.S. F.R.S. &c. and R. I. Murchison, Esq. For. Sec. G.S. F.R.S. &c.

Dec. 16.—Messrs. Lyell and Murchison's Paper, begun at the last Meeting, was concluded.

The theory, long since enounced, which ascribes the excavation of valleys to the long-continued erosion of streams, has been supposed to derive remarkable support from the appearances of the volcanic tracts in the interior of France; and the authors, referring especially to the works of M. De Montlosier, and the illustrations of that district recently published by Mr. Scrope, conceive that what they have seen themselves in Auvergne and the Vivarrais, strongly confirms the views of these and other preceding writers.

1. In the commencement of this paper, several peculiarities are stated in the original form of the lava-currents, or “cheires,” of Auvergne; which, if overlooked, might lead to an exaggerated estimate of the quantity of matter removed by the action of rivers. The abruptness, especially, of the lateral termination of many of these currents, is very remarkable; even where the lavas flowed in open spaces, and where the surface has remained entire and apparently unaltered since the time of their consolidation. But the authors still

conceive, that the waste exclusively attributable to running water and its detritus in Central France, must in the course of ages have exerted a most powerful influence on the external form of the country.

2. In the new Valley, about 250 feet in depth, opened at the Etang de Fung by the waters of the Sioule, after the stream had been diverted from its course by the lava of Come, the matter removed, and still continually carried away by the river, consists of alluvial clay and sand, and in some cases of the subjacent gneiss, which has thus been excavated to the depth of forty feet. That no general inundation contributed to this effect, is inferred from the total absence of sand, mud, or pebbles, on the surface of the lava of Come; although that current has occupied a low and exposed situation, ever since the period when the Sioule began to open for itself its present channel.

3. Near the volcano of Chaluzet, the Sioule has not only cut through more than 100 feet of compact basalt, but also the gneiss beneath, to the depth of at least 50 feet; the ancient channel of the river being marked by a bed of pebbles, intervening between the gneiss and the basalt, and now at a considerable height above the actual stream. And here the authors discovered an ancient mining gallery, driven in horizontally between the basalt and gneiss, so as to exhibit the pebble bed to the distance of fifty or sixty feet; a proof that this deposit was a true river alluvion, and not merely an external accumulation of debris covering superficially a mountain slope. The state of the cone and lava of Chaluzet demonstrates further, that no flood has passed over the country since the commencement of the excavation; and similar inferences are drawn from the condition of the cone of Montpezat in the Vivarrais. At Thueyts, in the same tract, the gneiss is worn into by the Ardèche, in one instance to seventy feet below an ancient alluvion overlaid by basalt. And in this valley an undulating band of pitchstone, at right angles to the vertical columns, occurs between the prismatic basalt and the subjacent gneiss; affording an exact parallel to the external portions of the dykes which traverse the oolitic strata in the Hebrides.

4. The lavas of the Vivarrais have suffered more from the action of rivers than the recent currents in Auvergne: but the greater velocity and volume of the waters, in the narrow and steep valleys of the former country, may account for this, without supposing the lavas to be much more ancient. In Auvergne, there are currents of ages unquestionably intermediate between the oldest and most modern; the remains of which are in many cases seen to follow the direction of the valleys, reposing upon ancient alluvions, and elevated above the modern lavas and the present rivers. The authors, however, do not admit that relative altitude can be considered as an invariable criterion of the relative antiquity of basaltic plateaus, as some writers have supposed.

5. In conclusion, a detailed account is given of the deposits at Mont-Perrier or Boulade; where the fossil remains of various extinct quadrupeds are found, alternating with beds of transported materials of different kinds, which rest against the sloping side of a hill to the height of between 200 and 300 feet. This hill itself is essentially



composed of tertiary marls, capped with basalt ; but the basalt does not here overlie the alluvions, as has been asserted.

Phænomena perfectly analogous to those of Perrier are exhibited on the Allier at St. Maurice, and in the hill of Monton, not far distant : and these three sections, as well as that above mentioned at the new passage of the Sioule, all concur in proving that many valleys in Auvergne, anciently excavated through gneiss and lacustrine marls capped with old basalt, have at some remote periods been filled up with transported matter, and afterwards been excavated a second time,—generally to a depth below their original bottom.

6. The authors conceive, with the writers already mentioned, that a satisfactory explanation of these phænomena may be derived from the effects of the latest volcanic eruptions of Central France. For the more recent lavas appear to have dammed up the channels of several rivers, and converted ancient valleys into lakes ; wherein, as at Aidat and Chambon, alluvial matter is continually accumulating at present. The modern lava of Montpezat, in the Vivarrais, has thus obstructed the course of the Fontaulier, and given origin to a lake, since filled with river alluvion and volcanic ashes ; and these deposits themselves, together with a part of the volcanic barrier, have been subsequently cut through, by the action of the river and the waters of the lake. The early and more copious lava-currents of Auvergne must have occasioned larger lakes than those of recent formation ; and these, as has been stated by other authors, seem to have been gradually filled up, with materials introduced by rivers, and occasionally by floods from the sides or craters of volcanoes, probably during their moments of eruption ; through which accumulations new valleys were excavated by the continued action of the rivers :—as at Mont-Perrier, to the depth of about 100 feet ; and at Maurice on the Allier, to 400 feet, below their original bottoms. The high antiquity of these alluvial depositions is inferred from the fact, that their lowest remnants occupy as elevated a position on the sides of the valleys, as the lava-currents of intermediate age in Auvergne ; and from the compactness and enormous mass of the trachytic breccias, which overlie and alternate with the alluvions.

7. Lastly, since the sand and gravel containing the fossil bones, found on two different sides of the mountain of Perrier, are overlaid by a vast mass of trachytic breccia, it is concluded, that the elephant, rhinoceros, hippopotamus, hyæna, tiger, wild cat and other quadrupeds, whose remains have been recently disinterred, must have been inhabitants of this district, before the most recent cones and lavas of Auvergne had appeared, or the valleys had been excavated to their present depth ; and even before the fires of Mont Dor were extinguished.

Jan. 2, 1829.—A letter was read, addressed to R. I. Murchison, Esq. For. Sec. G.S. &c. by G. W. Featherstonhaugh, Esq. F.G.S. “ On the Series of Rocks in the United States.”

Mr. Eaton has published, in Silliman’s *Journal of Science*, (vol. xiv.) a Synopsis of the rocks of North America. In the commencement of

the present Paper, the author, after having made himself acquainted by personal observation with the rocks of England,—states his opinion, that the rocks in North America, which would appear from Mr. Eaton's Synopsis to succeed one another in an order perfectly irreconcilable with that which has been observed in the British Islands, do in reality follow the same order.

A comparative view of the respective systems, of Mr. Eaton and the author of this letter, will be conveyed in the following table :—

*Series of North American Rocks.*

(According to Mr. Eaton.)

(Mr. Featherstonehaugh.)

Superficial Analluvion.

Stratified Analluvion.

Post Diluvion.

Ante Diluvion..... Diluvium ? ?

Basalt ..... Basalt.

3rd Grau- { Pyritiferous Grit } .. Coal measures of England.  
wacke. { Pyritiferous Slate }

Corniferous Lime Rock }  
Geodiferous Lime Rock } .. .. . Carboniferous Limestone.

Lias { Calcareous Grit }  
{ Calcareous Slate } .. .. . Lower Limestone Shale.

Ferriferous Rock.....

Saliferous Rock ..... } { Old red-stone, similar to that of  
Millstone Grit..... } { Monmouth.

2nd Grauwacke ..... Grauwacke Slate.

Metalliferous Lime Rock.. }  
Calciferous Sand Rock .. } .. . { Transition Limestone ; with En-  
Sparry Lime Rock ..... } { crinites, Madreporæ, Corals, Tri-  
lobites, Productæ, Spirifera, &c.

1st Grauwacke ..... Whetstone-Slate, and Alum-Slate.

Argillite ..... Clay-Slate, and Flinty Slate.

Granular Lime Rock ..... Primitive Limestone.

Granular Quartz.

Talcose Slate ..... Talcose Slate.

Hornblende Rock.

Mica Slate ..... Mica Slate.

Granite ..... Granite.

It is stated, moreover, to be the opinion of Mr. Eaton, that the coal measures of North America are analogous to those found at Cloughton on the Coast of Yorkshire ; and consequently that the English oolite, in which that coal is included, is represented by what he calls the third Grauwacke. The author dissents altogether from this doctrine. His opinion is, that neither the oolite, nor indeed any of the beds which are in England higher in the series than the coal measures, are to be found in North America, at least, north of 40° north latitude ; unless, perhaps, a very thick and extensive bed of marl, destitute of fossils, but containing *Septaria*, and not unfrequently pebbles, (designated by Mr. Eaton by the term antediluvion) ; —which, though the author has not been able as yet to refer them to any of the regular formations, may hereafter be found to belong to some stratum in the English Series.

In confirmation of the opinions here advanced, the author gives a detailed account of observations made by himself, in the course of an excursion from the City of Albany to the Hilderberg mountains, over a plain which extends about thirty miles from north to south, and sixteen miles from east to west. The surface of this plain, which is 324 feet above the level of the Hudson River, consists of sand incumbent upon a very thick deposit of the marl above noticed, which is found also in various parts of the United States, as far south as Louisiana. Near the Hudson River this marl is incumbent upon transition rocks; but at the Hilderberg mountains, it rests on carboniferous limestone, containing the fossils usually found in that formation, and imperfect seams of black chert or flint. This range is remarkable for its fissures and caves, one of which, more than 1500 feet long, situated in the town of Bethlehem, is minutely described by the author. Within this cavern is a pool of water, along which one of the attendants paddled himself in a small skiff, to the distance of 800 feet, in a course parallel to that pursued by the author, and separated by a screen of natural pilasters with occasional openings: this pool forms the head of a rivulet about one third of a mile from the entrance of the cave.—The author was unsuccessful in his endeavours to discover bones within the cavern, though it abounds in diluvial matter, which in some places presents a section of at least seven feet in height.—There is another cave in the same neighbourhood, said to be still more extensive, which he proposes to explore.

No regular search for bones has yet been made in the caves of the United States. The only fossil bones hitherto found in any cave in that country, are those of the megalonyx; although the bones of the megatherium, elephant, mastodon, ox and horse, have been discovered in other situations. But so little attention has been paid to the circumstances under which these remains occurred, that it is impossible to decide whether they were lodged in alluvial or diluvial deposits. In the author's opinion, no fossil remains of the hyæna, rhinoceros, hippopotamus, bear, or tiger, have ever yet been found in the United States.

A letter was read, addressed to Dr. Fitton, President of the Geological Society, by Samuel Woodward, Esq., respecting some remarkable fossil remains found near Cromer, in Norfolk.

The author notices the limited extent of the marine formation of Eastern Norfolk, and is of opinion that its rejectamenta may point out the boundary of a former sea in that district.

The marine remains, denominated Crag, are found at Cromer, and westward of that town, at Coltishall, and around Norwich. To the eastward of these situations, instead of marine shells, a layer of ligneous and mammalian remains is found reposing on the chalk.—The author considers that a line drawn from Cromer, or a little east of it, and passing in a south-east direction towards Lake Lothing by Lowestoff, will very nearly describe the course of the antediluvian shore;—to the eastward of which, immense numbers of the fossil remains of the elephant, horse, deer, &c. mingled with the trunks, branches and leaves of trees, have been found, even to the distance

of twenty miles out at sea; and on the Knoll-sand the tusk of a Mammoth (drawings of which are annexed to this letter) was found in the year 1826, resembling those recently brought to England from Behring's Straits.

Jan. 16.—An Appendix was read to Mr. De la Beche's Paper, on the Geology of Nice, by the Rev. W. Buckland, D.D. &c. &c. &c.

After bearing testimony to the correctness of the description given by Mr. De la Beche of the immediate neighbourhood of Nice, the author communicates his own observations made along the high road from that city to the Col de Tende, for the distance of about fifty miles.

The hill on the south of Scarena, twelve miles N.E. of Nice, presents a section of the green-sand formation, with nummulites, turritiles, and its other usual fossils, alternately with compact gray-limestone destitute of fossils. At Mont Brause the same beds of green-sand occur loaded with ammonites and belemnites.

On the descent to Sospello are found, in a regular descending series, green-sand, Jura, oolitic (or younger Alpine) limestone, lias, red-marle, and older Alpine limestone or dolomite, abounding in rauchwacke, and with vast beds of gypsum; on the N. of Brais mountain, is a similar section, at least 1500 feet in thickness.

In approaching the primitive chain we find in the vale of the Roya various beds of the new-red-sandstone formation, loaded, near Scorglio, with pebbles, (rothe-todte-liegende); and three miles beyond, at La Fontana, this conglomerate rests on a coarse red micaceous grauwacke, which is succeeded by primitive rocks.

From hence the author infers, that the lower part of the calcareous deposit near Nice, is the older Alpine limestone; as is the opinion of M. Risso. On the authority of that gentleman, Professor Buckland remarks, that near the source of the Var the older Alpine limestone contains gypsum, with sulphur and salt springs; and he thinks it probable, that the gypsum found near Vinaigre and Requiez, and at Cimiez, belongs to this formation, rather than to the younger Alpine limestone, to which Mr. De la Beche refers it. A similar development of the new red sandstone is seen between Toulon and Frejus, accompanied with gypsum, saccharine dolomite, rauchwacke, and conglomerate.

The author repeats, what he has advanced elsewhere, that although limestone of all ages is occasionally more or less dolomitic, yet it is peculiar to that of the new-red-sandstone formation, to be so very decidedly, and almost invariably. He dissents altogether from the theory which ascribes the magnesia contained in the calcareous beds of the Tyrol to the proximity of trap rocks; since he cannot conceive that strata many hundred feet thick, and many miles distant, so far as is known, from any pyroxenic rock, have derived from such rocks their magnesian character;—particularly as the beds, which are magnesian, are found not unfrequently to alternate with calcareous beds that are not so.

Jan. 16.—A Letter was read, addressed to the President of the Society, by MM. Von Oeynhausen and Von Dechen, containing

Observations on the mountain Ben Nevis, and on some other places in Scotland.

The authors of this communication, two Prussian naturalists, have here presented their observations on some of the more interesting portions of Scotland, which they visited about three years ago, with a view to a comparison of the rocks of Great Britain with those of the continent.

1. The Paper commences with a description of the great barrier of the Caledonian Canal: High mountains of crystalline rocks form its western boundary; conglomerate and sandstone, with subordinate beds of black calcareous shale, reach from the east to the upper end of Lochness; on the banks of the river of that name, is a flat pebble beach 150 feet higher than the sea, portions of which form islands that have the aspect of old fortifications.

Ben-Nevis is wholly crystalline: its summit consists of felspar-porphyry; its sides of granite, which rises to the height of 3000 feet above the sea, and is bordered by gneiss and mica-slate.

Near Inverlochy Castle, a low rock projecting above the surface of the bog, consists of mica-slate, alternating, as in the valley of the Spean, with gray granular limestone.

On the N. of Ben-Nevis, sienite containing mica and hornblende, both of them black, and therefore easily confounded, forms below the granitic declivity a narrow ridge nearly 1000 feet high.

On the right bank of Glen-Nevis, the schistose rocks are lower towards the west, and repose on the steep side of the granite, small hollows, however, intervening; they soon disappear on the north, but gain ground eastward.

A single summit only, of Glen-Nevis, consists of mica-slate; beneath are chlorite slate, and a rock composed of alternate laminae of compact white felspar and green mica; in the hollow below is contorted gneiss, connected intimately with the rock just described, or rather passing into it.

Compact white, and pale-green felspar occurs frequently in the slates, at and near their junction with the granite.

The granite at the sides of Ben-Nevis is large-grained, composed of flesh-coloured felspar, albite, gray-quartz, and black mica in equal proportions; higher up, it loses the albite and quartz, acquires a few specks of hornblende, and passes into a kind of felspar-porphyry; which last-mentioned substance constitutes the summit.

The junction of the granite and porphyry is laid bare on the E. and S. sides of the mountain; but on the N. and W. is concealed by scattered blocks of porphyry.

At the head of Glen Ptarmigan, is a steep cliff of porphyry, at least 1500 feet high. Its shape is that of an oblique four-sided pyramid, irregular and truncated, rising on the east and south, *through* the granite; and not merely overlying it, as M. Boué supposed. This fact the authors consider themselves as having fully established.

With equal confidence they affirm, that the gneiss and mica-slate are not conformable to the granite; and that the latter has forced its way through them: the granite traverses them also in the form of veins.

They remark further, the frequent occurrence of compact felspar, where these substances adjoin the granite.

2. The mountains N. of Ben-Nevis are chiefly mica-slate : S.E. of Loch Lochy this rock passes into gneiss ; on the sides of Glen Gloy, Glen Tuntick, and Glen Roy, it contains garnets, and alternates with quartz rock ; in the valley of the Spean it is interstratified with granular limestone.

Felspar, porphyry, and greenstone occur, in the mica-slate, in Glen Gloy, in Glen Roy, at Caldivan, and in the valley of the Spean.

The S. shore of Glen-Nevis, near Ballahulish, is a granitic aggregate of felspar and mica ; with concretions of mica and hornblende : granite occupies the low ground ; gneiss succeeds, passing eastward, into mica-slate and clay-slate, in which are beds of roof-slate alternating with, and traversed by, greenstone dykes, and interstratified with granular limestone.

In Glen Coe mica-slate is cut through obliquely by compact felspar-porphyry ; in the bed of the river is a fine-grained granite, with concretions like those of Ballahulish ; the granite is succeeded by gneiss at a lower level, and at a higher, by compact felspar, speckled and veined with epidote.

3. On the Isle of Sky the authors offer the following observations :

The syenite lies upon the hyperstene rock ; the passage into which is not gradual, but abrupt ; the hyperstene rock passes into compact greenstone, and often skirts the syenitic mountains ; the lias rests on syenite, or forms detached outliers ; and this observation holds good invariably.

There is no such thing as a vein of syenite in the lias. The transmutation of lias into white granular and compact limestone is more constant at its junction with syenite, than with greenstone or trap ; in the latter case it sometimes varies, sometimes not,—a circumstance difficult to account for.

The hyperstene rock seldom adjoins the lias ; when it does, like greenstone or trap, it both intersects and covers it.

Although the authors make a distinction between the rocks of syenite and those of trap and hyperstene, on account of their position relatively to the stratified rocks, they do not ascribe to the former a higher antiquity than to the latter ; for the syenite must be the production of a later æra than the lias, since it has materially altered it.

Feb. 6th.—A Paper was read, “On the discovery of a new species of Pterodactyle ; and also of the Fæces of the Ichthyosaurus ; and of a black substance resembling Sepia, or Indian Ink, in the Lias at Lyme Regis ;”—by the Rev. W. Buckland, D.D. F.R.S. Professor of Mineralogy and Geology in the University of Oxford.

1.—This specimen of Pterodactyle was discovered, in December last, by Miss Mary Anning, and was found to belong to a new species of that extinct genus, hitherto recognized only in the lithographic Jura-limestone of Sollenhofen,—which the author considers as nearly coeval with the English chalk.

The head of this new species is wanting, but the rest of the skeleton, though dislocated, is nearly entire ; and the length of the claws so much exceeds that of the claws of the *Pterodactylus-longirostris* and *brevirostris*, of which the only two known specimens are mi-

nutely described by Cuvier, as to show that it belongs to another species,—for which the name of *Pterodactylus macronyx* is proposed. A drawing of this fossil by Mr. Clift accompanies the paper. The author had for some time past conjectured, that certain small bones found in the lias at Lyme Regis, and referred to birds, belong rather to the genus *Pterodactyle*. This conjecture is now verified. It was also suggested to him, in 1823, by Mr. J. S. Miller of Bristol, that the bones in the Stonesfield-slate, which have been usually considered as derived from birds, ought to be attributed to this extraordinary family of flying reptiles: Dr. Buckland is now inclined to adopt this opinion, and is disposed to think still further, that the coleopterous insects, whose elytra occur in the Stonesfield-slate, may have formed the food of those insectivorous *Pterodactyles*. He conceives also, that many of the bones from Tilgate Forest, hitherto referred to birds, may belong to this extinct family of anomalous reptiles: and, from its presence in these various localities, he infers that the genus *Pterodactyle* was in existence, throughout the entire period of the deposition of the great Jura-limestone formation, from the lias to the chalk; expressing doubts as to the occurrence of any remains of birds before the commencement of the tertiary strata.

2.—*Fossil Fæces of the Ichthyosaurus*.—The author concludes from an extensive series of specimens, that the fossils, locally called Bezoar-stones, which abound at Lyme, in the same beds of lias with the bones of *Ichthyosaurus*, are the fæces of that animal. In variety of size and form they resemble elongated pebbles, or kidney-potatoes, varying generally from two to four inches in length, and from one to two inches in diameter; some few being larger, others much smaller. Their colour is dark gray; their substance, like indurated clay, of a compact earthy texture; and their chemical analysis approaches to that of album græcum. Undigested bones and scales of fishes occur abundantly in these fæcal masses. The scales are referable to the *Dapedium politum*, and other fish that occur in the lias; the bones are those of fish, and also of small *Ichthyosauri*. The interior of these bezoars is arranged in spiral folds; their exterior also bears impressions received from the convolutions of the intestines of the living animals. In many of the entire skeletons of young *Ichthyosauri*, the bezoars are seen within the ribs and near the pelvis: these must probably have been included within the animal's body at the moment of his death. The author found, three years ago, a similar ball of fæcal matter, in the collection of Mr. Mantell, from the strata of Tilgate Forest, which abound in bones of *Ichthyosauri* and other large reptiles; and he conjectures that these bezoars exist wherever the remains of Saurians are abundant.

3.—*Fossil Sepia*.—An indurated black animal substance, like that in the ink-bag of the cuttle-fish, occurs in the lias at Lyme Regis; and a drawing made with this fossil pigment, three years ago, was pronounced by an eminent artist to have been tinted with *Sepia*. It is nearly of the colour and consistence of jet, and very fragile, with a bright splintery fracture; its powder is brown, like that of the painter's *Sepia*; it occurs in single masses, nearly of the shape and size of a small gall-bladder, broadest at the base and gradually con-

tracted towards the neck ; these masses are always surrounded by a thin nacreous case, brilliant as the most vivid *Lumachella* ; the nacre seems to have formed the lining of a fibrous thin shelly substance, which together with this nacreous lining was prolonged into a hollow cone like that of a belemnite, beyond the neck of the ink-bag ; close to the base of the ink-bag there is a series of circular transverse plates and narrow chambers, resembling the chambered alveolus within the cone of a belemnite ; but beyond the apex of this alveolus, no spathose body has been found.

The author infers, that the animal from which these fossil ink-bags are derived, was some unknown cephalopode, nearly allied in its internal structure to the inhabitant of the belemnite ; the circular form of the septa showing that they cannot be referred to the molluscos inhabitant of any nautilus or *Cornu-ammonis*.

Feb. 6th.—A paper was read “On the Oolitic District of Bath,” by William Lonsdale, Esq., of Bath-Easton.

The tract described in this paper comprehends a space included between lines passing,—on the north, from Wicke north-west of Bath, through Marshfield, Kingston-St. Michael, and Lynham, to the Chalk-downs north of Calne and Cherhill ; and on the south and south-east,—from the south of Radstock, through Frome and Westbury to Devizes. The author refers to the works of Mr. Smith, and of Messrs. Conybeare, De la Beche, and Phillips, as the principal published authorities on the district ; and states his obligations for much valuable information to the Rev. B. Richardson of Farleigh, near Bath.

The geological boundaries of this tract are, on the west and north-west, the lias ; on the south-east and east, the Chalk-downs, extending from Salisbury Plain near Westbury to near Urchford, and thence to Cherhill-hill on the east of Calne. The series of strata which it includes, being the following, in a descending order.—

<i>Strata.</i>	<i>Thickness.</i> Feet.	<i>Strata.</i>	<i>Thickness.</i> Feet.
Lower chalk		Forest marble (continued)	
Chalk marl .....	150	clay .....	10
Upper green-sand .....	75	coarse oolite .....	25
Gault .....	150	sandy clay and grit	10
Lower green-sand .....	50	Bradford-clay ....	50
Kimmeridge-clay.....	150?	Great Oolite .....	140
Upper calcareous grit....	10	Fuller's-earth ....	150
Coral rag.....	40	Inferior Oolite	
clay .....	40	sandy oolite.....	60
calcareous grit ....	50	sand and grit.....	70
Oxford clay .....	300?		— 130
Kelloway rock....	5	marlstone .....	10
Cornbrash .....	16	Lias ; upper marl....	200
Forest marble		blue lias.....	50
clay .....	15	white lias ....	10
sand and grit ....	40	lower marl....	20
		— 280?	

The surface of the country described in this paper is characterized



by three ranges of hills connected by two plains.—1. The most western ridge is that of the great oolite, the highest part of which is 813 feet above the sea. It is separated, by the plain of the Oxford clay, from—2. The range of the coral-rag ; which again is detached, by the valley and plain of the Kimmeridge-clay and gault, from—3. The range of Chalk-hills.

The author describes in succession the several members of the series above mentioned : giving for each stratum an account of the range and boundaries, a general type of the succession and proportion of the component beds, with a detail of the physical characters and local peculiarities and names, and an enumeration of the organized remains, detailing the species of the fossils, with their localities and references to published figures. These copious details do not admit of abridgement.

The paper is illustrated by the corresponding sheets of the Ordnance-map, so far as they have been hitherto engraved, coloured geologically ; and by several sections explanatory of the succession of the strata, and of the forms of the surface.

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*The following Persons have been elected Fellows, and Foreign Members, since the commencement of the present Session.*

#### FELLOWS.

1828. Nov. 7th.—Joseph Henry Green, Esq. F.R.S. Mem. Royal Coll. of Surgeons, Lincoln's Inn Fields ; William Petrie Craufurd, Esq., Horse Guards ; and Joshua King, Esq. M.A. Fellow and Tutor of Queen's College, Cambridge.

Nov. 21st.—Frederick Page, Esq. of Goldwell House, near Newbury.

Dec. 5th.—John Auldjo, Esq. of Lancaster Place, Waterloo Bridge ; George Ormerod, Esq. LL.D. F.R.S. &c., of Tildesley in Lancashire, and of Sedbury Park, Gloucestershire ; and the Rev. David Williams, Rector of Bleadon, Somersetshire.

Dec. 19th.—William Frederick Hertzog, Esq. Assistant Surveyor-General at the Cape of Good Hope.

1829. Jan. 2nd.—William Gladdish, Esq. of Gravesend ; and Daniel Chambers Macreight, M.D. of 37 Somerset Street, Portman Square.

Jan. 16th.—Philip de Malpas Egerton, Esq. of Oulton Park, Cheshire ; Thomas Alderson, Esq. of Great Marlborough Street ; and Richard Cowlshaw Sale, Esq. of Surrey Street, Strand.

Feb. 6th.—Sydney Smirke, Esq. of Carlton Chambers, Regent Street.

#### FOREIGN MEMBERS.

1828. Dec. 5th.—M. Léonce Elie de Beaumont, Professeur Suppléant de Géologie à l'Ecole des Mines, Paris.

Dec. 19th.—François Dominique de Reynaud, Comte de Montlosier, President de la Société des Sciences, &c. &c., Clermont, Puy de Dome ; and M. J. M. Bertrand de Doue, President de la Société d'Agriculture, Sciences, Arts, et Commerce du Puy, Haute-Loire.

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# PROCEEDINGS

## OF

### THE GEOLOGICAL SOCIETY OF LONDON.

1828—1829.

No. 10.

#### AT THE ANNUAL GENERAL MEETING,

*20th February 1829;*

A Report from the Council was read, of which the following is an abstract :—

“ Comparative Statement of the number of the Society, at the last Anniversary, and at the close of the year 1828.

Fellows.	15th Feb. 1828.	31st Dec. 1828.
Having compounded .....	44.....	48
Contributing .....	150.....	147
Non-resident .....	211.....	223
	<hr/> 405.....	<hr/> 418
Honorary Members .....	55.....	51
Foreign Members .....	47.....	52
	<hr/> Total 507.....	<hr/> 521

“ The Names of the Fellows deceased, within the past year, are as follow :—

Compounders.....	{ William Hyde Wollaston, M.D. William Wood, Esq.
Contributing Fellows..	{ R. Stark Macmurdo, Esq. William Phillips, Esq. Henry Holland Stutzer, Esq.
Non-resident .....	{ John Braddick, Esq. Rev. E. E. Chaundy.
Foreign .....	{ (None.)
Honorary .....	{ J. R. Barclay, M.D. Richard Faber, M.D. Robert Lovel, M.D. John Lord Oriel.

*“Sums actually Received and Expended,*

## RECEIPTS.

	£	s.	d.	£	s.	d.
Balances in hand Jan. 1, 1828 :						
Banker .....	432	2	0			
Clerk .....	30	2	3			
	<hr/>			462	4	3
Arrears :	£	s.	d.			
of Admission Fees .....	23	2	0			
of Contributions .....	59	17	0			
of Rents .....	82	10	0			
	<hr/>			165	9	0
Ordinary Income :	£	s.	d.			
Annual Contributions, 1828 .....	414	10	6			
Admission-Fees :	£	s.	d.			
Resident .....	69	6	0			
Non-resident .....	168	0	0			
	<hr/>			237	6	0
	<hr/>			651	16	6
Compositions (seven) .....				217	7	0

Rents, to the end of the Society's occu- pation of Bedford Street .....	}			95	0	0
				£	s.	d.
Premium for lease of Bedford Street ..	25	0	0			
Valuation of Fixtures, &c. ....	63	13	0			
	<hr/>			88	13	0
Transactions sold .....	217	5	0			

[*N.B. The receipts from the Subscription for fitting up the Apartments in Somerset House, are placed to the Account of the “Repairing Fund;” which still remains open, and will be stated at the close of the current year.*]

£1897 14 9

during the year ending 31st December 1828."

PAYMENTS.		£	s.	d.
Bills of 1827; outstanding January 1, 1828 .....		181	7	8
General Expenditure :	£ s. d.	£	s.	d.
House repairs, Bedford St.	18 5 3			
Charges on removal from do.	30 14 9			
Taxes and Parish charges ..	91 19 2			
Do. Somerset House .....	4 10 2			
Insurance .....	9 11 5			
Furniture .....	36 6 9			
		191	7	6
Salaries and Wages:	£ s. d.			
Clerk .....	87 18 0			
Collector's Poundage .....	15 0 0			
Occasional Clerk .....	52 1 2			
Porter and Servants .....	61 4 8			
		216	3	10
	£ s. d.			
Coals .....	32 15 0			
Oil, lamps, candles, and } sundries .....	31 13 2			
		64	8	2
	£ s. d.			
Stationery .....	24 3 0			
Miscellaneous printing ....	26 2 0			
Books .....	17 19 0			
Bookbinding .....	4 12 9			
Arranging part of collection	11 11 0			
		84	7	9
Miscellaneous :	£ s. d.			
Petty expenses .....	65 5 6			
Tea (for Meetings) and waiters	20 13 3			
Sundry earthenware, &c. ....	14 12 11			
		100	11	8
		656	18	11
Rents paid, to the end of the Society's occupation } of Bedford Street .....		157	10	0
Cost of Publications :	£ s. d.			
Transactions .....	195 8 2			
Proceedings .....	31 14 8			
		227	2	10
Contributions repaid .....		9	9	0
		£1232	8	0
Balances in hand; 1st Jan. 1829.	£ s. d.			
Banker .....	607 4 9			
Clerk .....	26 12 0			
Collector .....	31 10 0			
		665	6	9
		£1897	14	9

"VALUATION of the Society's Property; 31st December 1828.

PROPERTY.		DEBTS, &c.	
	£ s. d.	£ s. d.	£ s. d.
Balances in hand. (See last page.)	665 6 9	Bills outstanding	109 9 0
Arrears due to the Society:	£ s. d.	Salaries, and Collector's	78 2 0
of Admission Fees	71 8 0	poundage	—
of Contributions	83 4 0		187 11 0
Estimated value of unsold Transactions	674 19 6		
[N.B. The value of the Collections, Library, and Furniture is not here included; nor is the amount of the "Donation Fund" instituted by the late Dr. Wollaston; being at present 1000 <i>l.</i> in the 3 per cent reduced Bank Annuities; the dividends thereof being appropriated to the purposes suggested by the Donor.]		Balance in favour of the Society; 31st Dec. 1829. 1807 7 3	
		<u>£1494 18 3</u>	

**"ESTIMATES for the ensuing year: to 31st December 1829.**

**"INCOME EXPECTED.**

	£	s.	d.
Arrears due to the Society 31st Dec. 1828 } (See last page.) .....	154	12	0
Ordinary Income 1829. (estimated.)	£	s.	d.
Contributions (of 155 Fellows) .....	450	0	0
Admission fees:			
of Residents (twelve) .....	75	12	0
of Non-residents (twelve) .....	126	0	0
Compositions, (estimated ;—four) .....	651	12	0
	126	0	0

Sale of Transactions ..... 200 0 0

Dividend from the "Donation Fund" instituted by Dr. Wollaston. (see p. 110) .... £1162 4 0

**"EXPENSES, ESTIMATED.**

	£	s.	d.
Debts, outstanding 31st Dec. 1828 .	109	9	0
Salaries and Wages, ditto .....	78	2	0
	187	11	0

**General Expenditure 1829:**

	£	s.	d.
House.			
Additions to outfit at } Somerset House .. }	100	0	0
Repairs .....	50	0	0
Taxes .....	40	0	0
Insurance .....	17	1	0
	207	1	4

**Salaries and Wages:**

Clerk and Assistance ..	160	0	0
Collector's poundage on 450 <i>l.</i> .....	22	10	0
Porter and Servant's wages	85	0	0
Waiters, Charwoman, and occasional assistants .....	25	0	0

292 10 0

Coals, Gas, Oil, &c. ..	60	0	0
Stationery .....	50	0	0
Miscellaneous .....	70	0	0

180 0 0

679 11 0

**Publications:**

Transactions .....	200	0	0
Proceedings .....	30	0	0

230 0 0

Employment of "Donation Fund" Dividends.. £1127 2 0  
Balance in favour of the Society ..... 30 0 0  
35 2 0  
£1162 4 0

“The MUSEUM has received many valuable donations since the last Anniversary, of which the following are the most important:—

### I. *British Specimens.*

- “A Collection of Fossil bones, from the Diluvium near Brentford; presented by the Rev. J. H. Randolph, F.G.S.  
 Fossils of the mountain limestone, from Closeburn, Dumfriesshire; presented by J. S. Menteith, Esq.  
 Various specimens of sandstone, conglomerate, and organic remains from Caithness; presented by the Rev. A. Sedgwick, V.P.G.S. Woodwardian Professor, Cambridge; and R. I. Murchison, Esq. For. Sec. G.S. F.R.S. &c.  
 Specimen of *Ichthyosaurus intermedius*; presented by H. T. De la Beche, Esq. F.R.S. G.S. &c.  
 Specimens of Fossil vegetables in Coal-shale, from Merthyr Tydfil in Glamorganshire; presented by Charles Stokes, Esq. F.R.S. S.A. G.S. &c.  
 Organic remains, found in digging the New Basin of the London Docks; presented by Henry Palmer, Esq. Engineer to the London Docks.  
 Specimens of Fossil antlers, and remains of a species of Deer, and Fossil remains of a species of Ox, found above the Chalk at Gravesend: presented by the Earl of Darnley, and William Gladdish, Esq. F.G.S. &c.  
 Two specimens of antlers of the Irish Elk; presented by the Rev. W. Buckland, D.D. V.P.G.S. F.R.S. Professor of Mineralogy in the University of Oxford.  
 Fossils of the London Clay, &c. from Highgate; presented by Bernard Geary Snow, Esq. F.G.S.  
 Casts of Bones of Fossil Crocodiles; presented by the Rev. W. D. Conybeare, F.R.S. G.S. &c.  
 Specimens of Fossil shells, rocks, &c.; presented by Sir Alexander Crichton, M.D. F.R.S. G.S. &c.

### II. *Foreign Specimens.*

- “Modern columnar Lava,—from the coulée of Jaujac, at the bridge of Naigles, Ardèche; presented by the Rev. Dr. Buckland, V.P.G.S. &c.  
 Casts of Fossil bones of various animals, particularly of the *Plesiosaurus* and *Mososaurus*; presented by the Baron Cuvier, For. Mem. R.S. and G.S. &c. &c. &c.  
 Fossil bones from the Caverns of Echenoz, near Vesoul; presented by J. B. Pentland, Esq.  
 Specimens from the vicinity of Christiania; presented by M. Otto Tank.  
 Specimens from the River Colombia, N.W. coast of America; presented by Mr. Alexander Douglas.  
 Specimens to illustrate a Paper on the Volcanic Districts of Central France; presented by C. Lyell, Esq. V.P.G.S. F.R.S. &c., and R. I. Murchison, Esq. For. Sec. G.S. F.R.S. &c.



“The LIBRARY has been increased by the donation of 74 volumes and smaller pamphlets.

“The third Part of a Second Volume of the Society’s TRANSACTIONS, (Second Series), has been published since the last Anniversary.

“PAPERS read at the Meetings of the Society, since the last Anniversary.

On the Geological Relations and internal structure of the Magnesian Limestone, and the lower portions of the new red-Sandstone Series; by the Rev. A. Sedgwick, M.A. F.R.S. V.P.G.S. Woodwardian Professor, Cambridge.

Topographical and Geological Notice, from information collected during the Expedition to the North-west coast of America, under the command of Capt. Franklin; by John Richardson, M.D. F.R.S. &c.

On the Fossil remains of two new Species of Mastodon, &c. found on the left Bank of the Irawadi; by William Clift, Esq. F.G.S. F.R.S. &c.

On a Collection of Vegetable and Animal remains and Rocks, from the Burmese Country, presented to the Geological Society by J. Crawfurd, Esq.; by the Rev. William Buckland, D.D. V.P.G.S. F.R.S. Professor of Mineralogy and Geology in the University of Oxford.

Extract of a Letter from Lieut. William Glennie, R.N. entitled, “The Ascent of Popocatapetl.”

A Letter from J. B. Pentland, Esq. to W. H. Fitton, M.D. Pres. G.S. F.R.S. &c. respecting the Fossil remains of some Animals from the N.E. coast of Bengal.

On the Old Conglomerates, and other Secondary Deposits, of the North coasts of Scotland; by the Rev. A. Sedgwick, V.P.G.S. &c. and R. I. Murchison, Esq. For. Sec. G.S. F.R.S. &c.

On the Cycadeoideæ, a new family of Fossil Plants; by the Rev. W. Buckland, D.D. V.P.G.S. &c.

A Letter to the President, with a list of the Fossils of Sussex; by Gideon Mantell, Esq. F.G.S.

On the Geology of Bundelcund, Boghelcund, and the Districts of Saugor and Jabalpoor in Central India; by Capt. James Franklin, of the Bengal Army, F.R.S. G.S. &c.

A Letter from Samuel Hobson, Esq. to Dr. Roget, F.G.S. Sec. R.S. &c. enclosing an account of some gigantic Bones; by Samuel W. Logan, M.D. &c.

A Letter from His Grace the Duke of Buckingham; with an account of the late Eruption of Vesuvius.

A Letter from Charles Stokes, Esq. F.R.S. G.S. &c. to W. J. Broderip, Esq. Sec. G.S. F.R.S. &c. explanatory of three drawings of Echini.

On the Geology of Nice; by H. T. De la Beche, Esq. F.G.S. F.R.S. &c.

On the Excavation of Valleys, as illustrated by the Volcanic Rocks of Central France; by Charles Lyell, Esq. V.P.G.S. F.R.S. &c. and R. I. Murchison, Esq. For. Sec. G.S. &c.

Letter addressed to R. I. Murchison, Esq. For. Sec. G.S. &c., by G. W. Featherstonhaugh, Esq. F.G.S. On the Series of Rocks in the United States.

Letter addressed to the President, by Samuel Woodward, Esq. respecting some remarkable Fossil remains found near Cromer.

An Appendix to Mr. De la Beche's Paper on the Geology of Nice; by the Rev. W. Buckland, D.D. V.P.G.S. &c. &c.

Letter addressed to the President, by MM. Von Oeynhausen, and Von Dechen, on the Geological Structure of Ben Nevis, and the neighbouring Country.

On the Discovery of a new Species of Pterodactyle; and also of the Fæces of the Ichthyosaurus; and of a black substance resembling Sepia, or Indian Ink, in the Lias at Lyme Regis; by the Rev. William Buckland, D.D. F.R.S. &c. &c.

On the Oolitic District of Bath; by William Lonsdale, Esq. of Bath-Easton.

“The following LIST contains the NAMES of all the Persons, from whom Donations to the Library and Museum have been received, during the past year.

American Phil. Society.  
Astronomical Society of London.

Beaumont, M. Elie de, Ingénieur des Mines, For. Mem. G.S. &c.

Bostock, John, M.D. F.R.S. G.S. &c.

Bouillet, M. J. B., Membre de la Société pour l'Industrie Nationale, &c.

Bowen, Captain.

Bristol Institution.

Broderip, W. J., Esq., Sec. G.S. F.R.S. L.S. &c.

Brongniart, M. Adolphe.

Brongniart, M. Alexandre, de l'Académie Royale des Sciences, &c.

Brookes, Joshua, Esq., F.R.S. L.S.

Buckland, Rev. W., D.D. V.P.G.S. F.R.S. Professor of Mineralogy and Geology, in the University of Oxford.

Charles, M. des Moulins, Pres. de la Société Linnéenne de Bourdeaux, &c.

Conybeare, Rev. W. D., F.R.S. V.P.G.S.

Coxe, L. S., Esq., F.G.S.

Crichton, Sir Alexander, M.D. F.R.S. L.S. G.S.

Croizet, M. L'Abbé.

Cuvier, M. le Baron, For. Mem. L.S. G.S. &c.

Darnley, Earl of.

De la Beche, H. T., Esq., F.R.S. L.S. G.S.

De Pierola, M. N.

De Rivero, M. M. E., Director General de Minería, &c.

Deveze, M. I. S. de Chabriol.

Directors of the Honourable East India Company.

Douglas, Alexander, Esq.

Ducrotay, M. H. De Blainville, For. Mem. G.S. &c.

- Dufrenoy, M., Ingenieur des Mines.
- Engelspach, M. la Riviere.
- Fiedler, Dr. Carl. Gustav.
- Franklin, Captain John, R.N. F.R.S. &c.
- Garnier, M. F., Ingénieur au Corps Royal des Mines.
- Gerolt, M. Frederico de.
- Gladdish, William, Esq., F.G.S.
- Gray, John Edw., Esq., F.G.S. &c.
- Harding and Lepard, Messrs.
- Hericart, de Thury, M. le Vis-comte, Conseiller d'Etat, Membre de l'Académie des Sciences, &c.
- Höninghaus, F. G., Esq.
- Horticultural Society of London.
- Leeds Phil. and Literary Society.
- Linnean Society of London.
- Loudon, J. C., Esq., F.G.S.
- Lushington, J. E., Esq.
- Lyell, Charles, Esq., V.P.G.S. F.R.S. &c.
- Mantell, Gideon, Esq., F.G.S. &c.
- Marcel, de Serres, Membre Correspondant de la Société Linnéenne à Montpellier.
- Martin, G. P., Esq.
- Martin, P. J., Esq.
- Menteith, J. S., Esq.
- Moses, Moses, Esq.
- Mousinho d'Albuquerque, M.
- Murchison, R. I., Esq., For. Sec. G.S. F.R.S. &c.
- Murray, John, Jun., Esq., F.G.S.
- Nelson, B., Esq.
- Nordenskiöld, Nils, Esq., Professor of Mineralogy, Abo. For. Mem. G.S.
- Palmer, Henry, Esq.
- Parkinson, J., Esq., Consul at Pernambuco.
- Pentland, J. B., Esq. Philadelphia Maclurian Lyceum.
- Randolph, Rev. J. H., F.G.S.
- Rang, M., Lieut. de Vaisseau.
- Richardson, John, M.D. F.R.S. L.S. &c.
- Roget, P. M., M.D. Sec. R.S. F.G.S. &c.
- Royal Academy of Sciences of France.
- Royal Asiatic Society.
- Royal Institution.
- Royal Society of London.
- Royal Society of Edinburgh.
- Rozet, M., Officier au Corps Royal des Ingénieurs Géographes.
- Scrope, G. P., Esq., F.R.S. G.S.
- Sedgwick, Rev. A., M.A. V.P.G.S. F.R.S. Woodwardian Professor, Cambridge.
- Silliman, Benjamin, M.D. L.L.D. Professor of Chemistry and Mineralogy in Yale College, North America.
- Snow, Bernard Geary, Esq., F.G.S.
- Stanhope, the Earl.
- Stokes, Charles, Esq., F.R.S. S.A. L.S. G.S.
- Tank, M. Otto.
- Taylor, John, Esq., Treas. G.S. F.R.S.
- Taylor, R. C., Esq., F.G.S.
- Taylor, Richard, Esq., F.L.S. G.S.
- Trevelyan, W. C., Esq., F.L.S. G.S.
- Twopenny, Mrs.
- Whewell, Rev. W., M.A. F.R.S. Professor of Mineralogy in the University of Cambridge.
- White, John, Esq.
- Yarrell, William, Esq., F.L.S. &c.
- Yates, Rev. James, F.L.S. G.S.
- Yorkshire Philosophical Society.
- Zoological Society.

The Council on the 10th. of December last, received from the late Dr. Wollaston, a communication to the following effect :

*" Dorset Street, December 8, 1828.*

" I have this day invested one thousand pounds three per cent. reduced Bank annuities in the joint names of myself and the Geological Society of London, in trust, that the said trustees shall, during my life, pay to me the dividends on the said stock ; and after my decease, that the said Society, as surviving trustee, shall apply the said dividends in promoting researches concerning the mineral structure of the earth ; or in rewarding those by whom such researches may hereafter be made, or in such other manner as shall appear to the Council of the said Society for the time being, conducive to the interests of the Society in particular, or of the science of Geology in general ; such latter application however, of the dividends to the purposes of science will, in my opinion, be most creditable to the Council.

" And I hereby empower the Council of the said Society, in furtherance of the above declared objects of this trust, to apply the said dividends in aiding or rewarding the researches of any individual or individuals, of any country ; saving only that no member of the Council for the time being shall be entitled to receive or partake of such aid or reward.

" And I hereby enjoin the said Society not to hoard the said dividends parsimoniously ; but to expend them liberally, and as nearly as may be annually, in furthering the objects of the trust.

" And I request the Society to entitle the fund hereby to be created, ' The Donation Fund ;' in full confidence, that as there never have been wanting in the Society members who, in cases of emergency, have been willing to contribute in aid of the ordinary funds of the Society ; so there now are, and hereafter will be members who will make additional contributions to this ' Donation Fund.'

(Signed)

" W. H. WOLLASTON."

" Witness, HENRY WARBURTON.

Whereupon it was resolved,—

" That the Council, on behalf of the Geological Society, do accept the trust, on the conditions mentioned in the communication of Dr. Wollaston, with gratitude and respect ; and they beg to assure him, that however important this accession to their funds may be, both in itself, and in the effect which they are convinced it will have in obtaining similar contributions from other Fellows ; hey attach still greater importance to it from the testimony which it conveys of his approbation, and of the interest which he takes in their pursuits."

The deeply lamented death of Dr. Wollaston since the date of the preceding document, having placed the property above mentioned entirely at the disposal of the Society, it will be the business of the Council for the ensuing year, to make such arrangements as shall be thought expedient, in order to carry his wishes, in the establishment of this " Donation Fund," into effect.

The Society, at a special meeting on the 18th of April, 1828, was informed of the grant from the Lords Commissioners of his Majesty's Treasury, through the mediation of the President and Council of the Royal Society, of apartments in Somerset-house; at which time a subscription was opened for the purpose of repairing and fitting up the apartments, whereby the sum of 923*l.* 8*s.* 6*d.* has been produced.

From that time till the entrance of the Society into their apartments, the attention of the Council was occupied unremittingly in making arrangements connected with the removal from Bedford-street, and in superintending the progress of the works necessary for the reception of the Society at Somerset-house. They disposed of the lease of the late premises in Bedford-street on satisfactory terms; and, under the direction of Mr. Decimus Burton, they were enabled to adapt the present apartments to their new purposes, much more effectually than at first was thought practicable. The Council hope that, considering the limited space for the reception and display of the collections, what has been done with these objects will be approved of by the Society, and be found effective and convenient.

The Council has the satisfaction of stating, that all the debts incurred to the present time, in repairing and fitting up the new apartments, have been entirely discharged; including the cost of a stove for heating the house with warm air, and of apparatus for supplying the lower rooms and staircase with gas light; and the purchase of several new cabinets and articles of furniture. The amount of these demands, from various and inevitable causes, has been found considerably to exceed what at first was hoped or expected. But the Council has, nevertheless, thought it expedient to pay off the whole, by taking from the ordinary funds of the Society a sufficient sum to make up the present deficiency of the subscription: leaving open, however, for the present, the subscription fund, and the account of the expenditure on the repairs; in order that such Fellows as have not yet subscribed, may have an opportunity, if they think proper, of adding their names to the subscription list; and thus, in effect, increasing the sum which will then be applicable to the essential purposes of carrying on the publications, and improving the Museum.

The Council cannot close what they have to state on this subject without informing the Society, that Mr. Decimus Burton, having throughout the progress of these operations, devoted to them his well-known skill and taste as an architect, has declined receiving any pecuniary compensation; stating that his satisfaction in being useful to the Society was much more acceptable to him than any such reward.

In the early part of the past year the arrangement of the Museum was improved, particularly of that part which relates to the English and Scotch series. All the specimens not yet introduced into the cabinets were examined, and numerous duplicates discarded. Considerable progress was made in classing the fossil bones, and at-

taching to them their proper names and localities: but the measures for completing these important operations were found to be incompatible with the transfer of the cabinets to their new situations.

The Council, however, has been careful to provide for the reception of such specimens as are not yet placed in the cabinets; and they have provided such places for storing them as will, they trust, prevent confusion, and insure facility of access to them. The Council has no doubt that the further measures necessary to render the collections effectively useful, will be carried into execution without delay, by their successors in office.

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The Report having been read, it was Resolved,—

1. THAT this Report be received.
2. THAT the thanks of the Society be given to W. H. Fitton, M.D. retiring from the office of President.
3. THAT the thanks of the Society be given to Arthur Aikin, Esq. Charles Lyell, Esq., and the Rev. A. Sedgwick, respectively retiring from the office of Vice-presidents.
4. THAT the thanks of the Society be given to Dr. Burton, retiring from the office of Secretary.
5. THAT the thanks of the Society be given to R. I. Murchison, Esq., retiring from the office of Foreign Secretary.
6. THAT the thanks of the Society be given to the Rev. W. D. Conybeare, John Crawfurd, Esq., J. W. F. Herschel, Esq., Henry Heuland, Esq., and Sir Richard Rawlinson Vyvyan, Bart., retiring from the Council.
7. THAT the thanks of this Meeting be given to Decimus Burton, Esq. for the valuable professional assistance which he has rendered, gratuitously, to the Society.

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The President then delivered the following Address from the chair.—

GENTLEMEN OF THE GEOLOGICAL SOCIETY,

You have heard in the report of your Council, that the favour of the Government, through the cordial interference of the Royal Society, has conferred upon us, since our last Anniversary, the Apartments in which we have now the satisfaction of being assembled. Having had an opportunity of becoming acquainted with the sentiments of the Council of the Royal Society upon this subject, I am justified in assuring you, that the most anxious desire has been expressed and acted upon by them, to promote the welfare and advance the purposes of our Institution; and I have the satisfaction of adding, that the mark of approbation with which the Lords Commissioners of the Treasury have honoured us, in this instance, is supported by similar proofs of confidence in other departments of the public service.

The best return for these marks of approbation, will be to con-

tinue to promote the researches for which we are associated ; and to render as useful as possible, to those who are engaged in the study of Geology, the various sources of information afforded by the collections and papers, which the liberality of your members and other contributors has entrusted to your charge. The Council has this day informed you of the measures which it considers eligible for these purposes ; and I need not remind the Fellows, that the prosperity resulting from the exertions of our predecessors can be upheld only by the continued activity of those who have leisure to assist, periodically, in the current business of our institution.

Among the members whom we have lost during the past year, we have had to regret the death of Mr. William Phillips, who had been for several years distinguished by his acquirements and publications on Mineralogy and Geology ; and whose name stands very creditably prominent in the list of persons, fortunately numerous in England, who, though constantly occupied in commerce, increase their own happiness, and promote useful knowledge, by the application of their hours of leisure to the pursuit of Natural Science.

Mr. Phillips was the author of several Papers in our Transactions, all of them containing proofs of the zeal and effect with which he pursued his inquiries. It was after the invention of Dr. Wollaston's reflective Goniometer, that his assiduity and success in the use of that beautiful instrument enabled him to produce his most valuable Crystallographic Memoirs ; and the third edition of his elaborate work on Mineralogy\* contains perhaps the most remarkable results ever yet produced in Crystallography, from the application of mere goniometric measurement, without the aid of mathematics. In our fifth volume Mr. Phillips has compared some of the strata near Dover with those of the opposite coast of France ; and has proved, that the cliffs on the two sides of the English Channel, though evidently portions of strata once continuous, must always have been separated by a considerable space. He was the author likewise of several detached works, which have materially promoted the study of Mineralogy and Geology. But the service for which he principally claims the gratitude of English Geologists, is his having been the proposer of the Geological "Outlines of England and Wales ;" in which his name is joined with that of the Rev. William Conybeare ; —a book too well known to require any new commendation, and to the completion of which we all look forward with increasing interest and expectation.

You have heard, in the Annual Report, the document by which Dr. Wollaston acquainted the Society with a donation intended for the advancement of Geological research. This Paper was dated on the 8th of December last : the tremulous and uncertain

\* "An Elementary Introduction to Mineralogy, &c. 3rd edition, enlarged, with numerous Wood-cuts of Crystals."—London, 1823.

character of the signature too evidently testified the declining state of the writer; and in a few days afterwards\*, not our Society, nor England only, but the whole scientific world had to lament his death.

In this place, and in the presence of so many to whom he was personally known, I could not trust myself to speak of Dr. Wollaston, so soon after the melancholy event which has deprived us of him, in the tone that might be suitable to a public meeting. And yet, if there ever was a man, in the estimate of whose character the feelings of private attachment might be allowed to mix themselves with scientific approbation, it was he: his personal and his intellectual qualities were so consistent; both flowing obviously from the same independence of spirit and strict love of truth; and both exhibiting, on all occasions, such admirable simplicity and good taste.

The greater number of Dr. Wollaston's productions belong to departments of inquiry which do not come within the object of our present consideration, and are recorded in the Transactions of that distinguished body, of which for many years he was one of the chief ornaments. His private life and character will be the subject of a Memoir, by a gentleman who was honoured with his intimate friendship. Our own Transactions cannot boast of any of his Papers; but he was well acquainted with the scope of our inquiries, and for several years before his death, he always attended to the geological phenomena of the countries which he visited in his excursions. He became a member of our Society in 1812; was frequently upon our Council, and for some time one of our Vice-Presidents; and the interest which he took in our welfare to the last, is fully testified by his recent liberal donation, and by the suggestions with which it was accompanied.

Indirectly, however, the labours and example of Dr. Wollaston, as a discoverer and a cultivator of chemical and mineralogical knowledge, have contributed in a most important degree to the recent progress of Geology. His application of Chemistry to the examination of very minute quantities, aided only by instruments so simple as scarcely to deserve the name of apparatus, by divesting chemical inquiry of much of its practical difficulty, has contributed materially to the progress of the more correct Mineralogy of our time: and the discovery of two new metals, with great and various additions to our acquaintance with the properties and uses of those already known, formed but a small portion of his chemical labours. His Camera Lucida is an instrument of universal application: but to the Geologist it is an acquisition of peculiar value, enabling those who are unskilled in drawing to preserve the remembrance of what they see, and giving an accuracy to sketches scarcely attainable by other

\* Dr. Wollaston died on the 22nd of December 1828. He was born on the 6th of August 1766.



means. The adaptation of measurement by reflection to Crystallography, by Dr. Wollaston's Goniometer, has introduced into that department of science a degree of certainty and precision, which, without its aid, are wholly unattainable,—and not even to be approached, but by the most dexterous and practised observers. His own success also, in the use of this beautiful instrument, was remarkable; and his Paper on the distinctions of the Carbonates of Lime, Magnesia, and Iron, is one of the most striking instances that can be mentioned, of the advantage arising from the union of crystallography with chemical research. He was in fact a Mineralogist of the first order,—if the power of deciding accurately on the characters and composition of minerals, by the combination of physical and chemical inquiry, be considered as the standard of skill.

Possessing such variety of knowledge, with the most inventive quickness and sagacity in its application to new purposes, Dr. Wollaston was at all times accessible, with unaffected facility, to those whom he believed to be sincerely occupied in useful inquiry: he seemed indeed himself to delight in such communications; and his singular dexterity and neatness in experiment rendered comparatively easy to him the multiplied investigations arising from them, which to others might have been oppressive or impracticable. His penetration and correct judgement upon subjects apparently the most remote from his own immediate pursuits, made him during many of the latter years of his life the universal arbiter on questions of scientific difficulty; so that his house became the common centre of resort to all who cultivated the Physical Sciences in England; and the instruction derived from such frank and easy communication with a man of his attainments, has had an effect on the progress of knowledge in this country, and on the conduct of various public undertakings,—the value of which, it would be difficult to estimate,—and the loss of which it is at present, and long will be, quite impossible to supply.

These, Gentlemen, are some of the grounds upon which the memory of Dr. Wollaston claims our gratitude and veneration, as cultivators of natural science: but to those who have known him in private life, he has left, what is still more precious, the example of his personal character. Few men can be named who more happily combined the qualities of a genuine English gentleman and philosopher; or whose whole life better deserves the praise which the first of our orators has given, as the highest eulogium, to one of our most distinguished public characters; for it was marked throughout by a constant wish and endeavour to be “useful to mankind\*.”

In adverting to the progress which Geological research has made during the past year in this country, I shall follow the descending order of the strata in our series; and I may refer to the Tabular View of our Stratification, of which Mr. De la Beche has recently

\* Fox's speech on the death of the Duke of Bedford, 1802.

published a second edition\*, for one of the most convenient and succinct views of the present state of our knowledge respecting them.

A complete account of the deposits which appear on the coast of Suffolk, and other parts of the eastern shores of England, especially of that which has been denominated CRAG, is still a desideratum of importance in the history of our strata. The publications of Mr. Robberds† and Mr. R. C. Taylor‡ have given some information of considerable value upon this tract: but a general account of it, combining the local phænomena with those of analogous deposits in other quarters, is still to be wished for; and from the connexion of the facts which our eastern shores exhibit, with some of the great questions touching the true theory of the diluvial accumulations, an acquaintance with them is almost necessary to the removal of some of the numerous difficulties which still attend that subject.

Mr. Webster has announced a new work upon the Isle of Wight; in which, under the simple form of a guide to that most interesting island, he proposes to illustrate fully its Topography and Geology; particularly the relations of the strata immediately above the chalk.

The true order of the beds between the chalk and the oolitic series, which has been the subject of much recent inquiry and discussion, appears now to be generally recognized; and considerable light has been thrown upon that remarkable group, united principally by zoological relations (for, mineralogically, its members are sufficiently distinct), which occurs between the lowest of the beds denominated green-sand, and the oolite of Portland. The succession, though the beds are not continuous, has been shown to be uniform throughout England, from Norfolk southwards,—and to be the same in fact with that long since enounced, though with much variation of nomenclature, by Mr. William Smith, in his Geological Maps of the English Counties.

A full and elaborate Catalogue of the Fossils of Sussex has been contributed by Mr. Mantell; whose labours as a Geologist, amidst the duties of an arduous profession, have long been so useful to the public, and so creditable to himself.—This valuable paper will be published in the next portion of our Transactions. Mr. Martin of Pulborough in Sussex, another member of the same profession, has published a detached Memoir, the developement of a Paper read here during the last session §; which, besides an account of the stratification in his own neighbourhood, contains much ingenious speculation on the phænomena which seem to have attended the elevation of the tract beneath the chalk, within the denudation of Sussex, Hampshire, Surrey, and Kent.

\* “A Tabular and Proportional View of the Superior, Supermedial, and Medial (Tertiary and Secondary) Rocks: 2nd edition, considerably enlarged,” by H. T. De la Beche, Esq. F.R.S. G.S. &c. London, 1828; Treuttel and Co.

† “Geological and Historical Observations on the Eastern Valleys of Norfolk,” by J. W. Robberds, Jun. Norwich, 1826.

‡ “On the Geology of East Norfolk,” &c. 8vo. 1827; by R. C. Taylor, F.G.S.

§ “A Geological Memoir on a part of Western Sussex,” &c. by P. I. Martin: 4to. London, 1828.

The accessions to our knowledge respecting the oolitic series, from the Portland strata down to the new-red-sandstone, have also been considerable during the past year. Mr. Lonsdale, I am happy to say, has presented us with an account of his researches on that important tract in the centre of England, included between the chalk near Calne and the vicinity of Bath; the maps relating to which I had the pleasure of laying before you at the last Anniversary. This valuable work, one of the most accurate perhaps yet produced in this country, may be considered as a more advanced stage of the inquiries respecting the oolitic tracts, begun so ably by Mr. Smith, and continued in Mr. Conybeare's *Outlines*: and it carries on the transverse section of England, from the vicinity of Bristol, which had already been illustrated by Mr. Conybeare and Dr. Buckland, in their admirable *Memoir* published in the first part of our *Second Series*.

The work upon the Coast of Yorkshire, announced by Mr. Phillips of the York Institution \*, will throw light upon a still lower portion of our oolites; and elucidate especially that remarkable group of strata which includes a series of coal-measures in connection with the lower oolite. It is certainly much to be desired that all our coasts were thus examined and distinctly represented; such illustration being valuable, not only in topographical history, but as affording the best evidence as to the succession of our strata, and the greatest facility to the study of them, both by foreigners and our own countrymen.

The complex and important groups which intervene between the Oolites and the Transition rocks, have been illustrated during the past year by Professor Sedgwick,—separately in England, and conjointly with Mr. Murchison, in the Isle of Arran and the north of Scotland.

Mr. Sedgwick's *Memoir* on the magnesian limestone, and the lower part of the new red-sandstone, in the north of England, is unquestionably one of the most valuable contributions we have hitherto received; not only supplying a desideratum of the greatest interest in our local Geology, but placing in a just light the difficult and obscure relations of that extensive series of beds which it describes. Nothing is now wanting, but the acquisition of good maps by the extension of the Ordnance Survey, to complete our geological acquaintance with the large portion of England described in this *Memoir*.

In Mr. Sedgwick's *Paper*, the new-red-sandstone is considered as constituting one great complex formation, between the lias and the coal-measures, with two calcareous formations subordinate to it; one (the muschel-kalkstein), in the upper part, which has not yet been discovered in our country; the other (the magnesian limestone), in the lower part, which the author has made especially the object of his researches.

\* This work has been published since this *Paper* was put to the press, and fully justifies the expectations entertained respecting it.

But although the Muschel-kalkstein has not yet been detected, and probably may not exist in any considerable force in England, it would be premature to assert that its equivalent may not still be detected among our strata; and this, with other circumstances, renders a good monograph of the new-red-sandstone formation, in the central and southern counties, a desideratum of importance. The general boundaries of the formation have been correctly traced; but the internal details remain to be investigated: and besides the necessity of searching in the upper part of the formation for the equivalent of those beds which are so conspicuous on the continent, the relations of the porphyritic masses of Devonshire and other places (which, it is remarkable, are found in combination with the saliferous red sandstone, not only in various parts of Europe, but even in India\*) are still very obscure. The publications of M. Charbaut†, M. Elie de Beaumont‡, and Messrs. Oeynhausien, Dechen, and De la Roche§ will be found to assist materially in these investigations.

The Magnesian-limestone itself, according to Mr. Sedgwick, admits of natural subdivision into five portions, which, in a descending order are:—1. A series of red sandstone and marl, superior to the dolomites, and subdivided into two portions; the equivalents of the *keuper* and the *bunter-sandstein*.—2. Limestones, containing magnesia and beds of dolomite, unequally diffused, but in much less proportion than in the lower parts of the series.—3. Red marl and gypsum, comparatively of small extent.—4. The great central deposit of yellow limestone, exhibiting various modifications of dolomite, frequently concretionary, in some cases oolitic; all of which apparently result from *internal* change of structure, subsequent to the mechanical deposition of the mass. These last formations (4, 3, and 2) represent the *Rauchwacke*, *Asche*, and foliated *Stinkstein*, the breccias, and gypsum of the Thuringerwald.—5. Variegated marls, with irregular beds of compact limestone, *Zechstein*. This formation is not co-extensive with the yellow limestone, but its place is constant; and its subordinate marl-slate is particularly distinguished by its fossils; among which are impressions of ferns, and the remains of fishes, some of them identical with those of the copper-slate of Thuringia.—6. And lastly, an extensive deposit of coarse siliceous sandstone (*rothe-todte-liegende*), of very unequal thickness; the upper beds of which are sometimes unconformable to the limestones which rest upon them. It is satisfactory therefore to find, that the great mass of strata, from the oolites down to the coal, admits precisely of the same subdivisions in the north of England, as upon the continent.

With respect to the theory of these magnesian formations, Mr. Sedgwick ascribes their production to the mechanical destruction

\* Geological Transactions, Second Series, vol. i. page 160.

† “Environs de Lons le Saunier.”—Annales des Mines, 1819, v. 579.

‡ “Observations sur quelques Terrains secondaires du Système des Vosges:” Paris, 1828; also published in the Annales des Mines for 1827.

§ “Geognostische Umriss des Rheinländer, zwischen Basil and Maintz:” 2 vols. 1825.

of rocks of the carboniferous order; stating however two facts, as yet imperfectly explained; 1st. The greater abundance of magnesia in the limestone formation than could have been derived from the dolomites of the carboniferous order;—and, 2ndly, The larger proportion of magnesia in some of the beds, than is found in the true dolomites; an excess which M. Elie de Beaumont has shown to exist also in the corresponding strata of the Vosges.

The want of conformity between the superior members of our series and the coal-measures, forms, it is well known, a prominent feature in the structure of the west of England:—which, besides its great importance to the coal-miner, has been supposed to mark an epoch in the order and circumstances of deposition; since a similar want of conformity exists in the north-west of France and Belgium,—and from recent observation has been found also on the flanks of the Vosges mountains\*; where the shafts for obtaining coal are frequently cut through the superior beds, to reach the unconformable strata beneath. It was a question therefore, of considerable interest, to determine how far this want of conformity might extend: and Messrs. Sedgwick and Murchison have shown that in Scotland, especially on the shores of the Isle of Arran, where a very distinct section is disclosed, the coal-measures are conformable in position to the incumbent strata; and that a gradual transition may be observed, in ascending, from the old red-sandstone, to the carboniferous series, with plants of the same species as of the English coal-measures; from which again there is a gradation into a series of conformable strata, supposed to be identical with the new red-sandstone of England. Hence it is not improbable that more extended inquiry will prove the *conformable arrangement* to be the more general one; and that the want of it, within the tracts above mentioned, is accidental, and comparatively of small extent: and this may be accounted for, by supposing, either that some local dislocation may have deranged a portion of the strata which would otherwise have been conformably disposed;—or, that an interval occurred between the deposition of the now discordant members, of such duration, and attended with such agencies, as to admit of considerable change of surface in the mass of strata first deposited.

The researches of Professor Sedgwick and Mr. Murchison in Scotland, contained in papers one of which has been already published, throw much light upon the relations of the lower part of our series to the crystalline masses beneath; and confirm the general diffusion in that country of our secondary strata;—though in detached portions, and generally accompanied by indications of disturbance, obviously proceeding from the primary masses on which they at present repose. It would exceed the limits to which I am here confined, to detail the results of which these memoirs give an account: the general inferences are,—1. The identity with the secondary rocks of England, of the strata in the Western-Islands,

\* Ann. des Mines, 1827, i. 431.

and throughout a large portion both of the east and west coasts of Scotland, is established on the evidence of fossils.—2. A formation of red sandstone has been observed on the shores of the Pentland Firth, which appears to occupy a space between the coal-measures and the new red conglomerates.—3. A great deposit of sandstone, with subordinate beds of dark bituminous limestone, occupying, apparently, the place of the coal-formation, has been designated,—but not yet perfectly identified with any formation hitherto described. The great thickness of this deposit and the ancient character of the rocks subordinate to it, prevent its reference to the German copper-slate : but the bituminous beds in Caithness contain impressions of fish including two new genera ; with other fossils, all resembling those of the inhabitants of fresh water.—4. The principal relations have been determined, of the conglomerates and sandstones which occur upon the north-west coasts, and the north-east of the Highlands, and range along the southern flank of the Grampian chain : and this great deposit is shown to be identical with the old red sandstone of England.

The disturbance of some of the newer strata in Caithness, is referred by the authors of these papers to the elevation of the granite beneath ; the amount of disturbance being in all cases nearly proportioned to the proximity of that rock : and it is rendered probable that the crystalline compound was upheaved, not in a fluid state, but after its consolidation ; since, although veins are numerous in other cases of contact of granite with incumbent rocks, neither veins or detached portions of the granite are in these instances to be met with in the shattered secondary strata which are placed upon it. There are few points more interesting to theory, than the general existence of such derangements on the confines of the primary and crystallized masses and of the stratified rocks : and this, without any other phænomena, might have led to a suspicion that the former were themselves the instruments, by which these dislocations were effected.

The existence in the N.W. of Scotland, of portions of strata probably deposited in freshwater, is another very interesting fact, for which we are indebted to Professor Sedgwick and Mr. Murchison : and it is particularly remarkable that the masses of limestone of this description discovered by these observers in the Isle of Skye, contain several of the same fossils (two species of *cyclas*, a *paludina*, and an *ostrea*) which occur also in the Weald-clay of our south-eastern counties\*.

It is my office here to mention what has been done by our contributors, or by members of this Society, with a view to publication in our Transactions. It is proper to add, that many of the

\* It deserves to be mentioned, that a species of *cyclas* very like the *medius* of the weald-clay (Sowerby, Min. Conch. tab. 527. fig. 2.) and of Skye, has since been discovered among the specimens brought by Captain Franklin from the N. coast of America. It was found in a loose mass of grey limestone on the beach, at the mouth of Babbage river, about 2° 30' W. of the Mackenzie. (Dr. Richardson, in Appendix to Franklin's Second Journey. p. xxvii.—spec. 355.)

relations of the rocks of Scotland were long since investigated by Dr. MacCulloch; who in addition to his previous works has recently begun to publish, in the *Journal of the Royal Institution*, the result of his observations on the north and north-eastern coasts: and I myself have seen in the hands of that gentleman, some years ago, several portions of an elaborate geological map of Scotland\*, of the greatest value. The labours of Professor Jameson likewise have been unremitting; and you are well acquainted with the various memoirs illustrating his native country, which he has published in the *Transactions of the Wernerian Society* and the other *Philosophical Journals of Edinburgh*.

From the situation of the capitals of England and France, at a distance from primary mountains, the study of the crystalline formations would there naturally occupy less attention than that of the stratified rocks; and with this circumstance, the extraordinary interest and novelty of recent zoological discoveries have concurred, to fix upon the newer strata,—not more attention than they deserve, but a degree of interest which has perhaps in some cases been too exclusive. The naturalist, however, who is in search of general laws, should exert himself to keep every part of his subject in view; and should never cease to remember, that, as in the study of the newer formations Zoology and Botany are his best allies,—so Mineralogy is indispensable to an acquaintance with the more ancient rocks,—and Chemistry as well as general Physics, to the solution of the problems connected with them. Mineralogy has, from various causes, been of late less vigorously pursued in England, than a few years ago; and it is probably to the previous labour which this subject requires, that we are, in part, to ascribe the comparatively backward state of our knowledge respecting the primary portions of this country. But though nothing has within the last year been published in our *Transactions* upon these formations, they have not been unattended to; and the *Memoirs* already produced, with those which are preparing for your perusal, will be found to throw great light upon the relations of our transition and primary rocks.

A memoir by Mr. Phillips, of the York Institution, describes a tract which is a branch from the great central mass of the slaty and primary rocks of Cumberland; and gives in detail the phenomena of a district remarkable for the numerous and striking proofs which it exhibits of dislocation,—of such amount, that in one instance strata have been brought into immediate apposition, which in their original situation were separated by a thickness of more than 500 feet.

The general relations of the mountain district of Cumberland had been already briefly but correctly described by Otley†, in a tract to which I have on a former occasion referred. I am now enabled, through the kindness of Professor Sedgwick, to state the general

\* See *Edinburgh Philosophical Journal*, vol. i. (1819), p. 418.

† *Lonsdale Magazine*, for October, 1820.

results of his own researches in that district, the detail of which I trust will soon be laid before you. These not only confirm and correct our knowledge of the Cumberland mountains, but determine some of the chief points of analogy which connect them, in structure and composition, with the primary and transition tracts of Wales and Cornwall.

In Wales, according to Professor Sedgwick, the old red-sandstone seems to pass gradually into the upper members of the following series.—

1. Grauwacke, containing in its upper part organic remains, and graduating into,—

2. The great slate-formation, containing in all its parts indications of mechanical origin.

3. A vast group, differing from the ordinary character of the Welsh mountains, in containing a very large proportion of felspathose rocks of porphyritic structure. Of this, the mountains of Snowdonia are probably the lowest portion.

4. In Anglesea, Professor Henslow describes\* a still lower group of slaty rocks, including chlorite and mica-slates, and quartz rock; the whole apparently dislocated by—

5. Protruding masses of granite.

In Cornwall and Devon, the well known order is—

- a. Grauwacke, with calcareous beds, sometimes containing organized remains.

- b. In two places, a formation of serpentine, which in the Lizard contains diallage-rock, talc-slate, hornblende, and mica-slates, appears to occur beneath the grauwacke. Its relations are obscure, but it is superior in position to the following formation.

- c. The great formation of metalliferous-slate (killas); with many subordinate beds of greenstone, felspathic-slate, &c.

[There is in Cornwall no proper representative of the porphyritic formations of Snowdonia (3.)]

- d. Granitic rocks, projecting veins into the incumbent slate; the granite itself being traversed by other veins of porphyry, called “Elvans.”

In Cumberland, the order is as follows:—

- I. The grauwacke system, containing calcareous beds with organized remains. It is unconformable to the overlying old red-sandstone.

- II. An enormous formation of green-slate, intimately associated with porphyry, like that of Snowdonia, and of Ben-Nevis in Scotland.

- III. A formation of clay-slate.

- IV. A series of crystalline schistose masses; forming the centre of the Skiddaw region, and composed of chistolite and hornblende-slates, gneiss, &c., apparently in irregular order.

- V. Granite†.

\* Transactions of the Cambridge Philosophical Society, vol. i.

† The mineralogical axis of all this tract extends from the centre of the Skiddaw region to the neighbourhood of Egremont. On the north of this



No. I, the grauwacke of Cumberland, is unquestionably the equivalent of the upper part of (a) the grauwacke-slate of Somerset, Devon, and Cornwall. No. II, the green-slate of Cumberland, has no representative of Cornwall; but seems to be identical with part of the Snowdonian formation of Wales (No. 3). No. III, the clay slate: And IV, the crystalline schistose rocks, present analogies with (c) the metalliferous killas of Cornwall. And on the whole, the suite of the transition and primary rocks in Cumberland assists in bringing together the phænomena of Wales and Cornwall; and in connecting the several groups in the distant parts of England, in a series of similar and probably contemporaneous formations.

We have received from our foreign members Messrs. Oeynhausén and Dechen, a Paper on Ben-Nevis, the loftiest summit in Scotland; to which I shall have occasion to refer, in connexion with a point of theory, on which it throws important light. And I mention this contribution with the greater pleasure, because I know that it is a peculiar gratification to the Society to receive the Papers of foreigners; and that if, in any instance, our aid, either as a Society or individually, has contributed to promote the inquiries of travellers in England, they may be assured that no return can be more grateful to us, than the illustration of our own country by their publications, or the application of the knowledge which they have acquired here, to elucidate the corresponding tracts of the Continent.

The labours of the Geological Society of Cornwall are continued: and a work, of which the first volume has been published, by Mr. John Taylor, one of the principal miners in this country, promises considerable additions to a department of knowledge comparatively new to our scientific literature, but intimately connected with our pursuits. This work is entitled "Records of Mining\*," and it proposes to embrace "reports and statements upon particular mines, and the produce of metals, in various districts; notices on Geological facts relating to mining; discoveries of ores and minerals, and descriptions of existing processes connected with the treatment of ores, and the operations of smelting, or other modes of reduction; with investigations of the methods of working now usually employed in

line the formations are repeated, with the exception of No. I., which is probably buried under the unconformable old red-sandstone and mountain limestone; and on this northern side, notwithstanding its less extensive developement, there is a group of mountains, almost entirely composed of diallage-rock (Euphotide) and other minerals, of which we have no trace on the south. These occupy the base of the green-slate and porphyry series, (No. 3.) of Wales; and seem to be in the exact place of (b.) the serpentine of the Lizard in Cornwall.

There is on the west side of Cumberland, another formation of granite and syenite, which underlies, traverses, and overlies the clay-slate, No. III., and is considered as the great centre of elevation of the region. It never overlies No. II.; but is probably connected with syenitic dykes, and other detached masses of crystalline rock, which do not belong to the ordinary rocks of superposition.

\* "Records of Mining, edited by John Taylor, F.R.S., &c.," 4to. with plates. London; Murray, 1829.

different countries, and of projected improvements; and descriptions of machinery or implements destined to the service of the mines." The editor justly adds, that many facts relating to these subjects, continually present themselves to observation, all record of which is lost, for want of a proper depository; and that not only is a quantity of valuable matter constantly occurring in the reports and statements upon our British mines, but that much more may be expected to reach us from those foreign countries in which English capital is now employed.

Mr. Taylor has prefixed to this first series of tracts, a Prospectus of a School of Mines in Cornwall; which contain suggestions well deserving the attention of those engaged in this important department of commercial speculation.

I have dwelt the longer upon that portion of our labours which refers to England, because the structure of this country is the primary object of our researches; since it is here, at home, that we can best, and in the first instance, acquire the rudiments of our subject, and gain that correctness of eye, and of judgment, which confers the right, as it were, to examine the geology of other districts,—and to claim, either from foreigners, or our own countrymen, that confidence in our accuracy, without which all attempts at comparison are vain. But in proportion as this country is known, a comparison with other regions becomes not only more interesting, but more necessary; and few, unfortunately, can be found, who, with sufficient knowledge of our subject, possess also the opportunity of travelling with geological views. In the mean time we must be grateful for all those contributions from remote countries, which, if they do not illustrate the relations of rocks, enable us at least to answer some questions respecting their local diffusion and comparative composition,—leaving their relations and many of the phenomena of structure to future inquiry.

In the foreign Geology of Europe,—we have the gratification of knowing that the examination of France, with a view to a general map of the strata, is steadily proceeding.

We ourselves have had Papers on the environs of Nice, from Mr. De la Beche and Dr. Buckland, giving a comparison of the strata in that neighbourhood, with those of England, and in some cases establishing their correspondence.

The proofs of the identity of the prevailing rocks in the more distant parts of the world, are continually multiplied, by the reception of authentic specimens; for which we have been of late indebted to the Admiralty, and to British officers, in the Navy and the service of the East India Company: and the donors of every such contribution,—even of the smallest specimen, the locality of which in a distant quarter is correctly ascertained,—will have the satisfaction of feeling, that they bring us nearer to the ultimate solution of the interesting problems which are before us.

We have received from Captain Beechey, commander of the late expedition to Behring's Straits, and from Lieut. Belcher, a valuable

series of specimens, collected in several detached points during the progress of that voyage: and, the notes taken by Lieut. Belcher and Mr. Colly having been put into my hands by Captain Beechey, I shall take an early opportunity of placing them before the Society. The only subject of regret relating to these Papers, is their brevity; for the notes, and the sketches connected with them, would do credit to the most experienced geologists.

A Paper, by Mr. Featherstonehaugh, read at one of our latest meetings, gives a comparison of the series of strata in the American United States, with that of England:—and various memoirs of Dr. Bigsby, some of which have been read before this Society, contain a copious statement of facts respecting Canada and a large portion of the adjacent country.

The Memoir of Dr. Richardson, read at one of our meetings, and published in the Appendix to the account of Capt. Franklin's second journey, contains a most valuable series of observations, made under great disadvantages, during the advance and return of that memorable expedition to the shores of the Polar Sea; in the course of which a space of about 5000 miles was for the first time surveyed and laid down,—the total distance travelled over by the party in America being not less than 14000 miles. The great similarity of the rocks, and of their structure and external features, to those of Europe;—the uniformity in composition of vast tracts of the country;—and the very large proportion of the surface occupied by water, especially within a broad calcareous band, that intervenes between the rocky mountains and another primary tract which has nearly the same direction, are some of the more obvious general results that may be collected from the perusal of this important Memoir, a full abstract of which will be found in our Proceedings. And the whole is rendered still more interesting to us, by the liberality of the collectors, who have placed in the Museum of the Society a complete series of the specimens described and referred to by Dr. Richardson.

I have already mentioned to you the contribution of Captain King from the southern extremity of America; which demonstrates the existence there of similar rocks, exhibiting analogous appearances, to those of Europe: and we have great reason to expect, from the number and activity of the British officers and agents, whom our numerous mining projects have distributed in South America, considerable additional light on the structure and phænomena of that extensive region.

From Africa we are still without any communication, from any of the Settlements on its extensive coasts.

I am happy to say, there is every day new reason to hope for the extension of geological inquiry in India; where the liberality of the Company in carrying on the magnificent Trigonometrical Survey has already laid the best foundation for such researches. A copy of the portion of the great map which has been already published has been presented to us by the Directors; and there is every reason to suppose, that they are as much disposed to favour Geology, as they have shown themselves to be to advance the pro-

gress of astronomy and scientific topography. We owe, under this head, considerable obligation to the exertions of our own distinguished member Mr. Colebrooke, whose activity and varied information have enabled him to contribute so much, to several departments of literature and science in connexion with the East.

The Asiatic Society, also, has recently taken up the extension of geological inquiry with much interest and zeal; and has opened an intercourse with India upon this subject, through Sir Alexander Johnstone, the chairman of their committee of foreign correspondence, from whence the best results may be expected. The attention of the Asiatic Society of Calcutta has of late been particularly devoted to this department of natural science; and we have, in the different Settlements, several friends and fellows of this Society, who have shown their desire to promote our views.

From Central India, Captain James Franklin has given us a Memoir on the vicinity of Bundelcund, illustrated with an excellent geological map and sections.

The Papers of Dr. Buckland and Mr. Clift, connected with the splendid collection of fossil remains from the Burmese territory, with which our Museum has lately been enriched, have been published in the last part of the Transactions: and the Council has endeavoured to diffuse the information afforded by this collection, by causing models of several of the fossils to be prepared, and distributed to some of the principal museums of Natural History. The Memoir of Dr. Buckland on the specimens from Ava, has shown the probability that the representatives of no fewer than eight of our formations\* exist in that region; and I shall presently refer to the interesting zoological results obtained from this splendid acquisition.

The Society has received from the Admiralty, in the course of the present session, a small collection of specimens, from the site of the intended settlement in the vicinity of Swan River, on the west coast of Australia; and Captain Stirling, before his departure from England, in the capacity of its Governor, was good enough to place in my hands some brief notes relating to them, which I shall take an early opportunity of laying before the Society. From the zeal expressed by that distinguished officer, we may regard this contribution, as an earnest of what may be expected hereafter from the colony under his superintendence: and having already received from the eastern shores of Australia enough to prove the resemblance of the rocks to ours, and even to point out the relative position and structure of the formations on some points of the coast, we may with reason expect the solution of some of the great questions respecting that region, which still are undetermined. It is remarkable, for example, that no traces have yet been descried, of any active volcano along the whole circuit of those shores; although the latitudes nearer to the Equator, and under nearly the same meri-

\* 1. Alluvium. 2. Diluvium. 3. Freshwater Marl. 4. London Clay and Calcaire-grossier. 5. Plastic Clay. 6. Transition limestone. 7. Grauwacke. 8. Primitive Rocks;—with indications also of the New-red-sandstone and Magnesian limestone.

dians, are the scenes of some of the most tremendous volcanic phenomena on record. The mode in which the waters condensed upon the vast continent of Australia are disposed of,—whether by evaporation from inland seas or lakes, or conducted to the ocean by rivers, whose existence has hitherto escaped detection, is another great question connected in all probability with its geological structure. But there is no subject of greater interest to us, at present, than the fossil organized remains of that country; a knowledge of which, especially of the remains of animals, will be an addition of capital importance to our subject, and probably not less valuable to the Zoologist. The diluvium, therefore, respecting which we have at present no information whatever, is deserving of the greatest attention: and since the existing races of Australian animals are so widely different from those of every other portion of the earth, the identity, on the one hand, of these animals with those occurring in a fossil state, would lead to some of the most important inferences; while on the other, the agreement of the fossil remains of Australia with the existing races of other regions, now disjoined from that country, would give new support to some of the most popular speculations of our day. With a view to these inquiries, scarcely anything that can be collected by our fellow labourers in that quarter, will be without interest to their friends in Europe.

The popularity which the study of ZOOLOGY continues to acquire in England, opens the brightest hopes in every department of inquiry connected with that important branch of natural history. Our Papers during the past year have added to the list of fossil animals two new species of Mastodon, connecting very beautifully the structure of the teeth in the animals of that genus previously known, with that of the Elephant. And Mr. Pentland has given an account of some fossils from Bengal, presented through the kindness of Mr. Colebrooke; which include the remains of a new *Anthracotherium*, and appear to have been situated in a deposit resembling some of the tertiary strata of Europe.

We owe to Mr. Broderip, one of the Secretaries of our Society, a Paper in the Zoological Journal\*, describing the Fossil jaw of a *Didelphis*, found at Stonesfield, the geological situation of which had been the subject of some debate; with a statement of the evidence by which its true place in our series of strata is proved to be within the oolitic-slate beneath the Oxford-clay, probably very near the site of the forest-marble.

From Dr. Buckland we have had a description of the remains of a new species of *Pterodactyle*, discovered by Miss Anning in the lias at Lyme Regis. The head of the only specimen yet found is wanting; but the remainder of the skeleton warrants the distinction of it from the two species described by M. Cuvier. The length of the claws, especially, is a prominent character; from whence the author has given to this species the name of *Macronyx*. Mr. Miller of Bristol, several years ago, suggested that the bones found

\* Zoological Journal, vol. iii. p. 408, &c.

in the Stonesfield-slate ought to be ascribed to this extinct family of reptiles; and Dr. Buckland entertains the same opinion respecting certain bones found also in the lias, at Lyme-Regis, and supposed to have been those of birds. The Pterodactyles consequently, would appear to have been in existence throughout the entire interval from the deposition of the lias to that of the chalk.

The author has connected with his Paper on the Pterodactyle, some observations on a substance analogous to album-græcum, produced apparently by the Saurian animals, whose remains are deposited in the lias; and on a dark colouring matter possessing the properties of Sepia and Indian ink, afforded by a fossil which exhibits a structure like that of the cuttle-fish. He is still engaged in the inquiries connected with these subjects; and has already obtained some very curious and unexpected results.

Mr. R. C. Taylor, one of our Fellows, has prepared a valuable list of the fossils hitherto discovered in the British strata\*, drawn principally from the works and authority of Mr. Sowerby, to whose indefatigable exertions in extending our acquaintance with the fossils of England Geology is under most essential obligation. The List details the genera in each of its divisions alphabetically; giving for each genus the number of the species most characteristic or abundant in each formation, with the principal localities where they occur. It is not susceptible of abridgement: but some of the results which can be expressed by numbers, have been thrown by the author into Tables, of which the following is a summary:—

Shells.		Simple Univalves.	Simple Bivalves.	Complex Bivalves.	Multi-locular Univalves.	Total numbers.		
{	Recent.	{ Total number of Species known. (from Wood's <i>Index Testaceologicus</i> ) .....		1961	874	58	2893	
	{	Fossil.	{ Total number of Genera .....		58	62   3	12	135
			{ Total number of Species .....		401	65 583   51	230	1265
				634				
{	Ancient Strata.	{ <i>Carboniferous Order</i> , of Cony-beare. (Species) .....		27	34   46	33	140	
		{ <i>Carboniferous beds</i> , to <i>Lias</i> . (Species) ..		9	33   5	50	97	
		{ Ancient strata, to <i>Lias</i> inclusive. Total of Species }		36	67   51	83	237	
	{	More recent Strata.	{ <i>Inferior Oolite</i> to <i>Chalk</i> inclusive. (Species) }		106	375   0	139	620
			{ Strata above the <i>Chalk</i> (Species) ..		259	516   0	8	408
		{ From the <i>Lias</i> to the most recent beds. Total of Species }		365	141   0	147	1028	
				147				

\* Now published in Loudon's Magazine of Natural History, for March 1829, Vol. II. p. 26, &c.

It appears therefore, that the total number of known existing species being about 3000, the number of fossil species is about 1300. And the author states, among other inferences from his Tables, that the ancient period is characterized by the complex shells, the middle by bivalves, the upper strata by the simple univalves; while, as we descend in the series of strata, we recede from the existing forms and proportions of numbers; 134 complex species out of 237 being found in the ancient beds, and only 147 out of 1028 in the more recent. These numbers, it will be observed, are connected with the system of Linnæus, and will probably be found to differ considerably from an enumeration according to the method of Lamarck: and the time perhaps is still remote, when any such comparison of numbers can be expected to come near the truth. The proportion of the known species to the total number, either of the existing or the fossil shells, is the result of circumstances in a great measure accidental,—the industry or success of collectors, and the greater or less extent to which the contents of the conchiferous strata are brought to light by human labour, or naturally disclosed: and all these sources of inequality must for a long time affect the different strata so unequally, that any general inferences now derived from the enumeration of species must be received with considerable qualification.

The Council has mentioned to you the late addition to the Museum, of a splendid series of casts of fossil remains, presented by the Baron Cuvier, and doubly valuable from their connexion with his own publications. These, in fact, are but continued proofs of the interest which that illustrious naturalist has always taken in the progress of this Society; and few of us have ever visited the French capital, without partaking, in person, of his hospitality, and deriving advantage from his aid in our inquiries. When the state of knowledge which many of us can remember, is contrasted with what we know at present respecting fossil organized remains,—now that we have acquired the power of determining from a single bone, or even a fragment, almost the entire structure and relations of animals, whose races are no longer in existence;—and when we recollect, that we owe to the same person the most complete history of fossil remains that has ever yet appeared, in richness of matter, in arrangement, and in style; and that all this is but a part of what one man has already performed,—we cannot be surprised at the eminence which he occupies in public opinion. The name of Cuvier is in fact identified with our subject; for, unquestionably, to no one now living is Geology so much indebted as to him: and he enjoys the enviable good fortune, not only of receiving from every side the tribute of admiration and gratitude arising from his works, but of witnessing himself the influence which they have shed, and are every day producing, on all the kindred departments of science, and in almost every quarter of the globe.

On the subject of FOSSIL PLANTS, we have heard, during the last session, a valuable Paper; and there are, at present, before the Society, several new specimens, which it is intended to figure and

describe without delay. The number of such specimens, in detached private collections throughout this country, we know to be so great, that when the wish of the Council to assist in describing and publishing them is generally known, we shall probably never want such a supply, as will enable us to connect with every future part of our Transactions some contribution to fossil Botany. Great benefit will thus be produced, by circulating information at present locked up and unavailing; and the specimens lent to the Society for illustration, will be rendered doubly valuable to the proprietors themselves.

The Botanical Paper, in the last part of our Transactions, is that of Dr. Buckland, on the *Cycadeoideæ*; a new family of fossil plants, discovered in the isle of Portland, and obtained most probably from a stratum immediately above the oolitic beds, which contains also lignite with the silicified trunks of dicotyledonous trees.

On the suggestion of Mr. Brown, these fossils have been considered as belonging to a family very nearly related to, but perhaps sufficiently distinct from, the recent Cycadeæ: and the observations of this distinguished Botanist, with respect to the stem or caudex of this family, are illustrated by sections represented in the plates which accompany Dr. Buckland's Paper.

The family of Cycadeæ consists at present of two genera, *Zamia* and *Cycas*. In certain *Zamiæ*, Mr. Brown states, there is one narrow vascular circle, divisible into radiating plates, and situated in the midst of the cellular substance of which the stem is in a great part composed. In *Cycas revoluta*, a second circle is added externally, at a small distance from the first; and in *Cycas circinalis*, (according to the only section of this plant yet published) the circles are more numerous,—the outermost being still considerably removed from the circumference.

The fossil stems, which are the immediate subject of Dr. Buckland's Paper, like the recent Cycadeæ, are not covered with true bark, but have a thick case, made up of the basis of decayed leaves, which externally form rhomboidal compartments, similar to those of the recent plants. The internal structure in the fossils, so far as hitherto examined, resembles that of the Cycadeæ, except in the more external position and greater breadth of the circle or circles visible in the section of the stem; a character whereby, Mr. Brown is of opinion, this fossil family approaches more nearly, than the Cycadeæ, to the ordinary structure of dicotyledonous woods; and consequently may be considered as supplying, from the fossil world, a link, which helps, in some degree, to connect the still distant structure of the Cycadeæ with that of the nearest existing family, the Coniferæ.

M. Adolphe Brongniart's publications on the History of Fossil Vegetables\*, though produced in another country, are too im-

\* "Prodrome d'une Histoire des Végétaux Fossiles;" published also as the article "Végétaux Fossiles," in the Dictionnaire des Sciences Naturelles; Paris, 1828.—"Considerations Générales sur la Nature de la Végétation," &c. Ann. des Sciences Naturelles; December, 1828.—"Histoire des Végétaux Fossiles," &c., publishing in Numbers.



portant to our inquiries not to be mentioned here. Some fear, perhaps, may be entertained, that his data are not yet sufficiently extensive to form an adequate base for his deductions; but there can be no question as to many of his inferences, nor respecting the impulse which the subject will receive from such an accumulation of facts as he has brought together. His views contrasting the climate of the globe at former periods and at the present time,—and his division of the epochs of geological deposition, as deduced from the study of fossil plants, in comparison with those which mere geological inquiry points out,—are most ingenious. Even if regarded as no more than the conjectures of so acute and indefatigable an inquirer, these speculations would be well deserving of attention; and altogether, his works on Fossil Plants must be considered as constituting one of the most valuable contributions to this department of Geology that has ever appeared.

The Paper of Messrs. Oeynhausén and Dechen, on the structure of Ben-Nevis in Scotland; and that of Messrs. Lyell and Murchison on the formation of valleys in Central France, give rise to some general reflections of great interest to theory: and though the tracts, in these two cases, are altogether different in geological character, the inferences derived from them, combine remarkably to support the opinions which at present prevail.

The summit of Ben Nevis, the highest mountain in Scotland, consists of porphyry; the flanks are granite, on which again is incumbent mica-slate. Messrs. Oeynhausén and Dechen have ascertained that the porphyry, instead of being an overlying mass, as has been asserted in similar cases, comes up *through* the granite; and that, as veins shooting from the granite are found to penetrate the incumbent mica-slate, so veins of the porphyry shoot into the granite itself, and thus demonstrate the more recent protrusion of the former compound. It has long been known, that granite, in the Isle of Arran and at Newry in Ireland, is traversed by veins of pitchstone, which itself is only a variety of porphyry: and Mr. Knox's detection of bitumen in pitchstone of every age, as well in various other rocks of the trap formation\*, coincides with this evidence, in demonstrating the igneous origin of that entire series of compounds. The light which the observations of Messrs. Oeynhausén and Dechen throw upon the "*Elvans*," or porphyritic veins of Cornwall, was alluded to in the conversation which followed the reading of their Paper here; for these Elvans are in fact great veins of porphyry: and since it would be inconsistent and unphilosophical to assign the production of phænomena of the same character to different causes, the probable origin of all veins, either by injection or sublimation from below, receives from these facts new and independent support.

The spirited publications of Mr. Scrope, especially his plates

\* Phil. Trans.; 1822 and 1823.

in illustration of the volcanic district of Central France, have renewed the attention of geologists in England to that country, from whence so many luminous views may be obtained on various points of theory. By placing the phænomena before the eye, Mr. Scrope has enabled his readers more easily to appreciate the merit of M. De Montlosier's admirable Essay on the Extinct Volcanoes of Auvergne\*; a work published more than thirty years ago, and containing most correct inductions and forcible reasoning on the origin of valleys, but almost unknown amongst us, till its doctrines were brought under our attention in a recent Paper of Messrs. Lyell and Murchison, which confirms M. De Montlosier's views by various new and interesting details. We are enabled, by this various assistance, to enter into the evidence derived from Auvergne, in support of the opinion which ascribes the origin of valleys, in many cases, to the gradual but long continued action of the streams of which they are now the channels:—a theory in fact brought forward several years before by De Saussure; to whose priority M. De Montlosier,—when conducted by other and independent evidence, to views precisely the same,—has very candidly given his testimony†.

I select these names from many of eminence, which might be mentioned, in connexion with this doctrine, and with the geology of Central France, because it is to De Saussure and to De Montlosier that we owe the principle, and to the beautiful drawings of Mr. Scrope, decidedly the best graphic illustration of that interesting tract. And I avail myself of this occasion to add, that De Montlosier's work affords a good example of the injury arising from our being too generally unacquainted with the publications of the continent. A few years, it is true, have materially changed the character of books upon Geology; but there is much in the topographical description of almost every country, which none of us ought to neglect. With the recent productions of France we are in general familiar; but we know much less than we ought to do, even of the

\* "Essai sur la Theorie des Volcans d'Auvergne : " Riom et Clermont ; 1802.—Anonymous.

† "Essai, &c. Chap. VI. "Des Revolutions operées par les eaux fluviales." The volume of De Saussure, referred to by M. De Montlosier, bears the date of 1786; the passages are in § 920; vol. i. 4to.

As M. De Montlosier's work of 1802 is stated to be only a reprint of the same publication in 1788, (Cuvier's éloge of Desmarest;—Eloges, II. p. 362,) it is the more remarkable that Mr. Playfair (whose illustrations of the Huttonian theory were first published in 1802,) does not appear to have been acquainted with it; since it cannot be doubted that he would have availed himself of such evidence, as that adduced by De Montlosier, from a series of phænomena entirely distinct from those to which he himself refers, in his sections on the proposition that "rivers have hollowed out their valleys;" which are composed with admirable force and eloquence. (Illustrations, §§ 315—329.) The perfect coincidence, therefore, between two such writers, without communication, and from facts entirely distinct, is strongly in favour of the correctness of their views in both cases.

modern publications of Germany: and of those of Italy, which include a great number of tracts on topography and physical geography, full of ingenious speculation and valuable detail, there are but few indeed with which we are acquainted. The description of our own country is but a step to what Geology is yet to become; and for the generalization which is wanting to render it worthy of alliance with the higher departments of science, the study of foreign productions is not only expedient as an economy of labour and time, but is demanded by justice and truth.

Messrs. Lyell and Murchison concur with De Montlosier and Scrope, in testifying that the valleys in Auvergne and the Vivarrais have been produced by the streams, in opposition to any more general or violent agency: and they regard the animal remains within the volcanic districts, as having been deposited in the bottom of lakes, filled up during the long course of years; their contents being again dispersed by the breaking down of their barriers, and the force of the currents thus set free. While, on the other hand, there is not upon the surface, even of the most recent lava-currents in that country, any trace of that more extensive diluvial action, nor any remnant of those masses of rock transported from great distances, which have been supposed to be of universal occurrence over the entire surface of the globe.

It is not here my province to enter into the discussion of these interesting questions, nor to pronounce an opinion upon them. It will be sufficient to have intimated, that much still remains to be done, even in this department of inquiry, the progress of which has been of late so very remarkable: and that as the doctrine of Werner, which ascribed to volcanic power an almost accidental origin, and an unimportant office, has long since expired; so the more recent views, which regard a certain class of causes as having ceased from acting, will probably give place to an opinion that the forces from whence the present appearances have resulted, are in Geology, as in Astronomy and general Physics, permanently connected with the constitution, and structure of the Globe.

Such, Gentlemen, is a brief statement of the product of our labours during the past year, and of some of the objects which you may perhaps regard as still deserving your attention. If, on comparing our subject with some other departments of physical research, we lament that we cannot avail ourselves of such aid as mathematical science furnishes to the astronomer; if the phænomena we are occupied in observing be inferior in sublimity to those presented by the heavenly bodies, and the laws we investigate less strict than those which govern their motions,—still do our inquiries claim a very high place as an exercise of intellectual power. The geologist, like the astronomer, is called upon to trace the effects of forces, not only vast beyond conception in themselves, but acquiring almost infinite augmentation of effect, from the numberless ages during which they have been unremittingly exerted: and

the problem, to explain the condition of the earth's surface at any moment of this career, is complicated as much perhaps as any other in physics, from the nature of the agents; of which change and irregularity appear to be essential characteristics. The degradation of the surface by the atmosphere, the erosion of streams and torrents, the encroachments of the sea, the growth and decay of the organized beings that successively inhabit the globe, with all the chemical and mechanical changes going on around us, though constantly in operation, are for ever varying in their energies and effects. The great phænomena of volcanic agency, which seems as it were to constitute one of the vital powers of the earth, are from their very nature transitory and erratic. Viewed, nevertheless, in relation to the vast periods of time, during which phænomena of the same kind have been continually recurring, these very accidents and apparent irregularities acquire a sort of uniformity. They intimate the repetition of results in future, resembling those which seem already to have occurred repeatedly in the history of the globe; and that part of the Huttonian theory, where the progress of geological revolution has been compared to the cycles, in the movements of the heavenly bodies,—in which, after a long series of periodical deviations, the same order is certain to recur\*,—seems to acquire new probability from every step of our progress, and to be really no less just, in a philosophic view, than it is captivating to the imagination. You need no incitement to persevere in such inquiries as these; your presence here is proof that you feel the attraction of them:—and if the conduct of your affairs calls off from the more seductive occupation of research, those who undertake the discharge of your official duties, they are consoled by the hope that they may have been of service to you, and by the proofs they continually receive of your confidence and indulgence. Of the value of these rewards, no one is more sensible than the person who now addresses you:—I thank you, Gentlemen, most sincerely for the kindness with which you have assisted me in the discharge of my duties as President; and, in transferring my office to the able hands by which it will be directed during the next two years, I bid you, most respectfully, Farewell.

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The Meeting then proceeded to the election of the Officers and

\* “The Geological system of Dr. Hutton resembles, in many respects, that which appears to preside over the heavenly motions. In both, we perceive continual vicissitude and change; but confined within certain limits, and never departing far from a certain mean condition, which is such, that in the lapse of time the deviations from it on the one side must become just equal to the deviations from it on the other. In both, a provision is made for duration of unlimited extent; and the lapse of time has no effect to wear out or destroy a machine constructed with so much wisdom.”—Playfair's Illustrations:—§ 387, note xx.

Council for the ensuing year ; when the following list was delivered in by the Scrutineers :—viz.

*President.*

Rev. Adam Sedgwick, M.A. F.R.S. Woodwardian Professor, Cambridge.

*Vice-Presidents.*

Rev. William Buckland, D.D. F.R.S. Professor of Mineralogy and Geology in the University of Oxford.

George Bellas Greenough, Esq. F.R.S. L.S. & H.S.

Leonard Horner, Esq. F.R.S. Warden of the London University.

Henry Warburton, Esq. M.P. F.R.S.

*Secretaries.*

William John Broderip, Esq. F.R.S. L.S. & H.S.

Roderick Impey Murchison, Esq. F.R.S. & L.S.

*Foreign Secretary.*

Charles Lyell, Esq. M.A. F.R.S. & L.S.

*Treasurer.*

John Taylor, Esq. F.R.S. & H.S.

*Council.*

Arthur Aikin, Esq. F.L.S. Secretary to the Society of Arts.

James Ebenezer Bicheno, Esq. F.R.S. Sec. L.S.

John Bostock, M.D. F.R.S. L.S. & H.S.

Decimus Burton, Esq.

Capt. George Everest, F.R.S. Superintendant of the Great Trigonometrical Survey of India.

Michael Faraday, Esq. F.R.S. Cor. Mem. of the Academy of Sciences at Paris.

William Henry Fitton, M.D. F.R.S. & L.S.

Davies Gilbert, Esq. M.P. Pres. R.S. F.S.A. &c. &c.

John Lindley, Esq. F.R.S. & L.S. Professor of Botany in the London University.

Rev. John Honywood Randolph, M.A.

Peter Mark Roget, M.D. Sec. R.S. F.L.S.

Nicholas Aylward Vigors, Esq. M.A. F.R.S. Sec. Zool. Soc. &c.

Nathaniel Wallich, M.D. F.L.S.

Rev. James Yates.





PROCEEDINGS  
OF  
THE GEOLOGICAL SOCIETY OF LONDON.

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1829.

No. 11.

March 6.—S. P. Pratt, Esq., of Lansdown Place West, Bath; and the Rev. Robert Everest, M.A., of Devereux-Court, Temple, were elected Fellows of this Society.

An account of a remarkable fossil-plant in the coal-formation of Yorkshire; by John Lindley, Esq., F.G.S., F.R.S., &c., and Professor of Botany in the University of London, was read.

This plant was described as a fern, resembling, in most respects, the *Trichomanes reniforme*, a recent species found in New Zealand, but differing in the nature of its venation. It was said to exhibit distinct and unequivocal traces of the marginal fructification peculiar to the genus *Trichomanes*. After comparing it with the fossils comprehended by M. Adolphe Brongniart in his genus *Cyclopteris*, and showing that it was not referable to any known species of that group, the author concluded by assigning to it a specific character, and the name of *Trichomanes rotundatum*.

The reading of a paper "On the remains of Quadrupeds which have been discovered in the Marine and Freshwater Formations of the Peninsula of Italy;" by J. B. Pentland, Esq., was begun.

March 20th.—R.W. Blencowe, Esq., M.A., of 10, Gloucester-Place; R. Otway Cave, Esq., M.P., of 30, Upper Grosvenor-street; Captain Samuel Edward Cook, R.N., of Newton, Northumberland; Robert Daubeny, Esq., of Cork-street; George Lowe, Esq., of Highgate; and J. P. Fearon, Esq., of 1, Crown-Office-Row, Temple,—were elected Fellows of this Society.

A paper was read, "On the Tertiary and Secondary Rocks forming the Southern Flank of the Tyrolese Alps, near Bassano;" by Roderick Impey Murchison, Esq., Sec. G.S., F.R.S., &c.

The tertiary, or sub-alpine rocks which fringe the southern extremity of the Tyrolese Alps, between the rivers Brenta and Piave, may be said to divide themselves into two great natural groups of very different ages.

1st.—An outer, or younger zone composed of conglomerates with subordinate beds of yellow sand and blue marl containing shells, which, from a limited number collected by the author, seem to be identical with those which in other parts of Italy, at Nice, &c. characterize the newer tertiary formations (Sub-Apennine).

2d.—An inferior system of yellow and green calcareous sandstone, blue marl, and compact limestone; the higher portions of which offer a few shells analogous to those of the Bourdeaux basin; while the lowest beds are distinguished by a vast variety of organic remains,

more than one half of which seem to be identical with the species found in the Calcaire grossier and London clay.

A nummulite limestone forms the base of the above series, and is shown to be conformable to the scaglia, or rock containing ammonites, belemnites, and flints (the equivalent of the chalk), which rising into the Alps, passes into a dolomitic limestone charged with casts of fossils of the oolitic series. No rocks of igneous origin interfere, in this district, with the above order of superposition; but they are largely developed to the west of the Brenta, where they cut through the regular deposits. In illustration of the above, two transverse sections from S. to N. are then detailed.

1st.—From Asolo to Possagno, exhibiting the youngest group or conglomerate rising to the height of from 700 to 800 feet above the Adriatic, and dipping S.S.E. at angles increasing from  $25^{\circ}$  to  $40^{\circ}$ .

The dip and direction are the same in the succeeding strata of marl and limestone, for the space of five miles, and near Possagno they range conformably to the scaglia; with which, however, the lowest members of the tertiary series are there not seen in contact, owing to a denudation in the Val d'Urgana.

2d.—From Bassano to Campese in the Canal di Brenta. This section, owing to the much higher inclination of the beds, exhibits all the above members of the tertiary and secondary series in the short space of two miles. At Sarzon the marls of the Calcaire grossier inclined at  $70^{\circ}$  to  $80^{\circ}$ , are succeeded by a compact nummulite limestone, absolutely vertical; forming piers on each bank of the Brenta. This vertical nummulite rock is in positive and conformable contact with the scaglia, or ammonite rock, and they rise together to peaks of considerable height. The scaglia passes conformably into a dolomitic limestone, with remains of the oolitic series which forms the principal mass of this and the higher regions of the neighbouring Alps.

From the preceding facts, the author infers that some of the last expansive forces by which the secondary strata of the Tyrolese Alps have been set on edge, have also raised the tertiary deposits into their present vertical positions. Such forces, he presumes, found their issue in the adjoining basaltic and trap-rocks west of the Brenta. He next points to the above sections, as proofs that unconformability is not an invariable test of the distinction (if any such there be) between secondary and tertiary formations; and in describing the entire absence of the plastic clay in this district, he further remarks that it would be in vain to seek here for those various subdivisions of the tertiary series which exist in certain parts of Europe, and which some geologists would desire to establish as general types of these formations.

April 3.—J. S. Upton, Esq., M.A., of Trinity College, Cambridge; Edward Wynn Pendarves, Esq., M.P., of Pendarves, Cornwall, and of 39, Grosvenor-street; the Rev. John Lodge, M.A., Fellow of Magdalen College, Cambridge, and principal Librarian of the University of Cambridge; the Rev. John Brown, M.A., Fellow of Trinity College, Cambridge; Captain John Franklin, R.N., F.R.S., &c. Com-



mander of the late Expeditions overland to the N.W. coast of America, of Devonshire-street, Portland Place; and W. A. Cadell, Esq., F.R.S. L. & E. of Edinburgh,—were elected Fellows of this Society.

A letter dated March 14, 1829, from Dr. Prout to Professor Buckland, was read, stating that since the last meeting he had made an analysis of the bezoar stones from Lyme Regis and Westbury on Severn, and found the composition of all of them to be very similar, viz. : phosphate of lime and carbonate of lime, together with minute variable proportions of iron, sulphur, and carbonaceous matter. The relative proportions of the principal ingredients appear to differ somewhat in different specimens, and even in different parts of the same specimen: hence no formal analysis has been attempted; but the phosphate of lime may perhaps be estimated to constitute from about one-half to three-fourths of the whole mass.

Dr. Prout conceives this composition to prove that the basis of these bezoar stones is bone; and that Professor Buckland's opinion that they are of fæcal origin, or of the nature of Album Græcum, offers a very satisfactory explanation of their occurrence, and accounts at once for their chemical composition, their external form, and their mechanical structure.

A paper "On the Bituminous Schist and Fossil Fish of Seefeld in the Tyrol," by Roderick Impey Murchison, Esq. Sec. G.S., F.R.S., &c., was read.

The bituminous schist of Seefeld is subordinate to a vast formation of dolomite, forming a lofty mountain chain which separates the Tyrol from Bavaria, in which it occupies a thickness of several hundred feet. This slaty rock is quarried solely for the bitumen it contains, which is extracted by subjecting the schist, when broken up and placed in crucibles, to an intense heat during ten or twelve hours. The only animal remains observed were fossil fish; and amongst these M. Valenciennes has discovered at least four species, three of which are distinguished by quadrangular scales without articulating points, thus resembling the *Esox osseus* (*Lepisosteus* Lacépède), but differing essentially from that genus in having a forked tail, as also in the position and structure of the fins; whilst another specimen is distinctly referred by him to the genus *Clupea*. With these ichthyolites were found a few vegetables, one of which has some resemblance to a *Lyopodium*.

As the general characters of the fish approach to those of the Kupfer Schiefer of Germany, of the magnesian limestone of England, and of the Caithness schist in Scotland, while on the other hand they differ entirely from all the species hitherto observed in the lias and oolitic series, the author, combining this fact with the mineral characters of the Seefeld rock and those of the metalliferous dolomite to which it is subordinate, refers the deposit to one of those formations below the new-red-sandstone so universally abundant in ichthyolites. He further speculates on the probability of the destruction of so many fish having materially cooperated in the bituminization of the schist, because this rock, on distillation, gives off a much larger proportion of ammonia than has ever been detected in any coal, however bitumi-

nous. Lastly, the author dissents entirely from the theory of Von Buch that the dolomitic mountains of the Alps have derived their magnesia from augite rocks in fusion, and their peaked forms from a simultaneous alteration of their structure :

1st.—Because no trap or augite rocks occur in this region.

2d.—Because fossil fish and plants in bituminous schist alternate with beds of the dolomite, which must therefore have been of contemporaneous origin.

3d.—Because the peaked outline of these mountains is sufficiently explained by the high inclination, vast dislocations, and numberless contortions, of the strata.

The reading of a paper, "On the tertiary deposits of the Cantal, and their relation to the Primary and Volcanic Rocks;" By C. Lyell, Esq., For. Sec. G.S., F.R.S., &c. ; and Roderick Impey Murchison, Esq., Sec. G.S., F.R.S., &c., was begun.

May 1.—Samuel Cartwright, Esq., of 32 Old Burlington Street, and John Hall, Esq., of Edinburgh, were elected Fellows of this Society.

The reading of a paper "On the tertiary deposits of the Cantal, and their relation to the primary and volcanic rocks," by Charles Lyell, Esq., For. Sec. G.S., F.R.S., &c., and R. I. Murchison, Esq., Sec. G.S., F.R.S., &c. begun at the last meeting, was concluded.

The authors have selected this district for description, because, although the adjoining fresh-water formations of the Limagne d'Auvergne, and of Puy en Velay, have been largely written upon ; yet this of the Cantal has scarcely been noticed by any geologists, except in a cursory manner by Mr. Scrope, and formerly by M. Brongniart in his general observations on fresh-water deposits. (*Annales du Museum*, tom. xv. 1810.)

The fresh-water formations of Aurillac, or the Cantal is not a continuous portion of the great lacustrine deposits of the Limagne d'Auvergne, from which it is distinctly separated, being bounded on the north, west and south, by gneiss and mica schist, and on the east chiefly by granite. The vast volcanic eruption of the Plomb du Cantal, the highest point of which is 5571 French feet above the sea, burst out within the area of this ancient and elevated lacustrine deposit long after the consolidation of its strata, which have in consequence been fissured in every direction from that great centre, and covered both by igneous and aqueous dejections ; the limestone and marls being capped with sloping terraces of breccia and basalt, while the streams flowing from the central heights have widened the fissures into deep valleys. Two of the principal of these valleys, which radiate in a westerly direction from the Plomb, are occupied by the rivers Cer and Jourdanne, which unite near Aurillac, where the volcanic matter being about twenty-five miles from its point of eruption, has thinned out to a few irregular cappings, and consequently the lacustrine strata are there least obscured.

From an examination of numerous escarpments, the details of which are given in separate sections, the authors establish the following descending order.

1. Strong beds of white limestone, alternating with marls, and containing the following fossils :—*Limneus longiscatus*, and others ; *Planorbis rotundatus*, and cornu ; *Ancylus elegans*, &c.

2. White thinly foliated marls and marlstones, with a vast proportion of flinty and resinous silex, both in layers and in nodules, the latter frequently having the characters of the menilite of the Paris basin, containing innumerable *Bulini*, chiefly *Bulini conicus* and *pygmæus*, with *Potamides Lamarckii*, and a great quantity of stems of vegetables with gyrogonites. This middle system is distinguished by the paper-like lamination of its beds ; and from the succession of matted vegetables and minute organic remains, it offers throughout many striking analogies to deposits in recent lakes. (Some of the thicker calcareo-siliceous beds are extensively worked for millstones.)

3. The base of these deposits is a brownish red plastic clay, charged with white quartz pebbles, &c., the detritus being apparently derived from the gneiss and mica schist, on which it rests.

The united thickness of the lacustrine formations of the Cantal is estimated at from 400 to 500 feet.

Several detached remnants of water deposits are mentioned as occurring between Aurillac and Mauriac ; and although the authors conceive these may possibly have been formed in tarns (or small lakes), yet from the prodigious convulsions which the whole country has undergone posterior to the lacustrine deposits, it cannot be determined whether these might not have been bays of the great lake of the Cantal.

That a vast change in the relative levels of the various rocks of this region has taken place, is proved by many of the escarpments of the fresh-water marls being now at much greater heights than the border primary rocks on which they rest. The mineralogical appearances of the white limestone and marl are compared with the chalk of England, like which their surface is occasionally hollowed out into root-shaped cavities filled with alluvium ; while some of these fresh-water flints are found strewed over the adjacent primary rocks, just as chalk flints are spread over the granite of Peterhead, Banffshire.

The valley of the Cer is then described. In ascending the deep gorges of this valley to the Plomb du Cantal, or centre of igneous eruption, the lacustrine strata gradually losing the horizontality which they exhibit at Aurillac, are found first much disturbed, then dislocated, isolated and altered, amidst trachytic breccia and basalt ; and finally above Thiesac are entirely lost under the increasing mountainous accumulations of volcanic matter. Siliceous fragments inclosing fresh-water shells are found at such very high levels in some of these ancient trachytic currents, and so much above any remnant of the fresh-water strata *in situ*, that the authors conceive they must have been ejected from below, and borne down from the central heights of the volcano, mingled with the detritus of volcanic rocks. In confirmation of what has been previously stated, that the great volcanic focus burst out within the area of the lacustrine deposits, it is stated that limestone and marls occur near Murat at the foot of the

Eastern watershed of the highest ranges of the Cantal, where beds extensively quarried for lime, and containing several species of *Limneus*, *Planorbis*, *Bulinus terebra*, &c. with gyrogonites and plants, are overlaid by a prodigious accumulation of volcanic products. The fresh-water strata at this locality (La Vissiere) are unaltered in their character, but exhibit many faults.

The organic remains found in different parts of the Cantal, prove that this lacustrine formation, although geographically separated from, is geologically of the same age with that of the Limagne d'Auvergne, and corresponds as a whole to the different divisions of the fresh-water strata of Paris, and those of Hordwell Cliff and the Isle of Wight in England. It is more difficult to obtain an accurate knowledge of all the strata in the Cantal, than in the contiguous regions of Mont Dor, Clermont, &c. For in the last-mentioned districts, the volcanoes had issue amidst the primary rocks, their lava currents only reaching to the outskirts of the lacustrine formations; whereas those of the Cantal burst out in the very centre of these tertiary deposits, and either buried them or produced changes of the relative levels of the country, so as to occasion much abrasion of the original strata by the frequent shifting of the direction of the waters.

In conclusion, a comparison is instituted between the lower members of the lacustrine deposits of the Cantal, and those of the Limagne d'Auvergne and of the Puy en Velay.

A paper by Dr. Buckland was read, stating that he has ascertained that the bony rings of the suckers of cuttle-fish are frequently mixt with the scales of various fish, and the bones of fish, and of small *Ichthyosauri* in the bezoar-shaped *fæces* from the lias at Lyme Regis. These rings and scales have passed undigested through the intestines of the *Ichthyosauri*. Dr. Prout has also found that the black varieties of these bezoars owe their colour to matter of the same nature with the fossil ink bags in the lias; hence it appears that the *Ichthyosauri* fed largely upon the *sepia* of those ancient seas.

The author has also ascertained, by the assistance of Mr. Miller and Dr. Prout, that the small black rounded bodies of various shapes, and having a polished surface, which occur mixt with bones in the lowest strata of the lias on the banks of the Severn, near Bristol, are also of *fæcal* origin:—they appear to be co-extensive with this bone bed, and occur at many and distant localities. He has also received from Mr. Miller similar small black *fæcal* balls from a calcareous bed nearly at the bottom of the carboniferous limestone at Bristol; this bed abounds with teeth of sharks, and bones, and teeth and spines of other fishes: until they can be referred to their respective animals, the author proposes the name of *Nigrum Græcum* for all these black varieties of fossil *fæces*. They may have been derived from small reptiles or from fish, and in the case of the lias bone bed, from the molluscous inhabitants of fossil nautili and ammonites, and belemnites. In a collection at Lyme Regis there is a fossil fish from the lias, which has a ball of *Nigrum Græcum* within its body; for this the author proposes the name of *Ichthyo-copros*. He also proposes to affix the

name of Sauro-copros to the so-called bezoar stones of the lias at Lyme Regis, which are derived from the Ichthyosauri ; and the name of Hyaino-copros to the Album Græcum of the fossil hyæna.

The form and mechanical structure of the balls of Sauro-copros, disposed in spiral folds round a central axis, are so similar to that of the supposed fir-cones or Iuli in the chalk and chalk marl, that the author has concluded that these so long misnamed Iuli are also of fæcal origin. On examination he finds many of them to contain the scales of fish ; and Dr. Prout's analysis proves their substance to be digested bone. The spiral intestines of the modern shark and ray afford an analogy that may explain the origin of this spiral structure ; and the abundance of the teeth of sharks and palates of rays in chalk renders it possible that the Iuli may have been derived from these animals. For these the provisional name of Copros iuloides is proposed. In the collection of Colonel Houlton, of Farley Castle, are several specimens of the Copros iuloides from the quarries of Maestricht.

The author has also recognized two other varieties of these fæcal substances in a collection of fossils brought from the fresh-water formations near Aix in Provence by Messrs. Murchison and Lyell.

The author concludes that he has established generally the curious fact, that, in formations of all ages, from the carboniferous limestone to the diluvium, the fæces of terrestrial and aquatic carnivorous animals have been preserved ; and proposes to include them all under the generic name of Coprolite.

The examples he produces from the carboniferous limestone, the lias, the Hastings sandstone, the chalk marl and chalk, the Maestricht rock, the fresh-water deposits at Aix, and the diluvium, are taken respectively from the several great periods into which geological formations are divided.



PROCEEDINGS  
OF  
THE GEOLOGICAL SOCIETY OF LONDON.

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1829.

No. 12.

May 15.—Wm. Babington, Esq., of St. John's Wood, Regent's Park; and Henry Humphry Goodhall, Esq., of the East India House, were elected Fellows of this Society.

The reading of a paper, "On the Hydrographical Basin of the Thames, with a view more especially to investigate the causes which have operated in the formation of the valleys of that river, and its tributary streams;" by the Rev. W. D. Conybeare, F.G.S., F.R.S., &c., &c. was begun.

June 5.—William Lonsdale, Esq., Lieut. 4th Reg. of Infantry, and late Honorary Curator of the Bath Philosophical Institution, &c., &c.; the Rev. Thos. Thorp, M.A., Fellow of Trinity College, Cambridge; the Right Rev. John Matthias Turner, D.D., Lord Bishop of Calcutta; David Douglas, Esq., F.L.S., of Turnham Green; Thos. Erskine Perry, Esq., B.A., of Trinity College, Cambridge, and Whitehall; and Charles Earl, Esq.,—were elected Fellows of this Society.

The reading of a paper, On the Valley of the Thames, by the Rev. W. D. Conybeare, F.G.S., F.R.S., &c., &c., (begun at the last meeting,) was concluded.

The author has selected this river, not only as being the principal one of the island, but further as exhibiting valleys exclusively the result of denudation, and therefore better suited to illustrate that operation than valleys of more complicated origin, in the formation of which the elevation and dislocation of the strata have co-operated.

He first offers some introductory remarks on the opposite theories of the fluvialist and diluvialist, the former ascribing such denudations exclusively to the operation of the streams actually existing, or rather to the drainage of the atmospherical waters falling on the districts, which it is supposed have become thus deeply furrowed by the gradual erosion of these waters, continued through a long and indefinite series of ages; the latter contending that such a cause is totally inadequate to the solution of the phænomena, and maintaining that they afford evidence of having been produced by violent diluvial currents.

He proceeds to distinguish several different geological epochs, at which it is probable that currents must have taken place calculated to excavate and modify the existing surface. I. In the ocean, beneath which the strata were originally deposited. II. During the retreat of that ocean. III. At the periods of more violent disturbance, which are evidenced by the occurrence of fragmentary rocks, the result of violent agitations in the waters of the then existing ocean propagated from the shocks attendant on the elevation and dislocation

of the strata.—Four such periods are enumerated as having left distinct traces in the English strata. 1. That which has formed the pudding-stone of the old-red-sandstone, ascribed to the elevation of the transition rocks. 2. That which has formed the conglomerates of the new-red-sandstone, ascribed to the elevation of the carboniferous rocks. 3. That which has formed the gravel beds of the plastic clay. 4. That which has produced the superficial gravel, spread alike over the most recent and oldest rocks as a general covering, and which is found to contain bones of extinct mammalia : this (it is agreed) may be identified as the product of one æra, by the same evidence which is employed to demonstrate the unity of any other geological formation. Although diluvialists have usually directed their principal attention to the effects of the currents of this latest epoch of general disturbance, they by no means exclude the co-operation of any of the causes above enumerated.

In the body of his paper, the author considers the physical history of the Thames as divisible into the following sections. I. The collection of its head waters from the drainage of the Cotteswold uplands. II. The passage which it has forced across the Oxford chain of hills. III. That opened in like manner across the Chiltern hills to the London basin at Reading. IV. The re-entry of the river among those hills by the Henley defile. V. Its course through the plains of London to the sea.

I. The head-waters of the Thames are collected from the drainage of the Cotteswold uplands, over a tract about 50 miles in length, constituting the rivers Isis, Churn, Colne, Lech, Windrush, Evenlode, and Cherwell; this chain of hills being entirely broken through by the Colne, Evenlode, and Cherwell, which rise from sources in the Lias plains beyond its escarpment. The height of most of these sources is calculated at about 400 feet above the sea.

Each of these valleys is separately described, and the general features of denudation presented by the Cotteswold chain are pointed out; these, it is asserted, bear traces of the most violent action, and they are contrasted with the state of repose which has evidently prevailed in the same districts from the period to which our earliest historical monuments ascend. In the most exposed situations, and those which appear to have suffered most from the action of the denuding causes, earth works of British and Roman antiquity are frequently found, attesting by their perfect preservation that the form of the surface has remained unaltered since the time of their construction. The drainage of the atmospherical waters has here produced no sensible effect for more than fifteen centuries: it is inferred, therefore, that to assign to this cause the excavation of the adjoining valleys, 600 or 700 feet deep, is to ascribe to it an agency for which we have no evidence; the evidence, indeed, as far as it can be examined, being adverse.

The disposition of the water-worn debris drifted against the Cotteswold chain and through the breaches opened in it, is also examined; and much of it is shown to be derived from rocks situated to the north of the valley of the Warwickshire Avon, and to be completely cut off



by that valley from the Cotteswold district. It is contended that pebbles of this origin can never have been transported by the actual streams, because the drainage of these streams is, and always must have been, from the escarpment of the Cotteswolds to the valley of Avon; whereas the course of the pebbles is directly opposite, viz. across the Avon, and thence to that escarpment and through its breaches. The valley of Shipston on Stour, which is described as a species of bay in the escarpment of the Cotteswolds, is stated to contain the most remarkable instance of this disposition.

II. The river collected from these head-waters flows through the plain of Oxford, which is covered to a great extent by water-worn debris; these are diffused over situations inaccessible to the present floods, and if produced by the actual streams, we must suppose that they have repeatedly changed their channel so as to have flowed successively over every portion of the plain where these debris are now found: the oldest historical monuments attest, however, the permanence of the actual channels, and the floods at present bring down no pebbles whatsoever.

On the south of the plain of Oxford the progress of the river is opposed by a chain of hills, called by the author the Oxford chain. This is passed by a defile broken through it. Were that defile closed, an extensive lake would be formed above Oxford, and the waters would be turned into the valley of the Ouse; by which they would empty themselves into the æstuary of the Wash.

The author inquires how this configuration of the valleys could have been produced on the fluvialist's theory. He argues, that if the Oxford chain originally (as at present) formed a barrier of superior elevation to the tract intervening between itself and the Cotteswolds, that barrier must have turned all the drainage of the Cotteswolds into the vale of Ouse: under those circumstances the crest of the Oxford chain could never have been eroded by waters which would have flowed off in another direction. There is, however, another alternative; and the interval between these chains may be supposed to have formed originally a uniformly inclined plane, from the summits of the one to those of the other, along which the waters once flowed, and which they have since furrowed (by perpetually deepening their channels) into the present valleys. The author calculates the mass of materials which must on this supposition have been excavated and washed away, and contends that the drainage of atmospherical waters along such an inclined plane (which would have a fall of 10 feet per mile) does not afford an agent adequate to such vast operations.

The Oxford chain has suffered greatly from denudation, being broken into several detached groups.

Among these, some insulated summits are capped by patches of gravel, partly derived from transition rocks, partly from the chalk formation. These prove the extent to which denudation must have proceeded since they were lodged in their present situation; as they must have been transported from their native habitats along uniformly inclined planes, which have subsequently been excavated.

III. Issuing from the defile of the Oxford chain, the river flows

through the plain of Abingdon and Dorchester, being joined by the Ock and the Thame. This plain, like that of Oxford, is deeply and extensively covered with water-worn debris. It is also similarly bounded by a lofty chain (like that of the Chilterns) on the south. An enormous breach is opened in this barrier for the passage of the river. All the same arguments apply in this case which were previously urged with regard to the passage of the Oxford chain.

The Chilterns, like most other chalky districts, abound with dry valleys, the rifted and absorbent structure of that rock not permitting the rain waters to collect into streams: these valleys agree in every other feature with those containing water courses, and have been obviously excavated by the same denuding causes, which, in this case, it is self-evident could not have been river waters. The surface of the chalk has been deeply and violently eroded, and is deeply covered with its own debris;—this action appears, in part, to have taken place during the epoch of the plastic clay formation.

IV. The river having passed this defile, enters for the first time the London basin, near Reading; where it receives the Kennet, of which the course is shortly described. It rises in the chalk marl, beneath the chalk escarpment, a few miles beyond Marlborough; that escarpment being broken through in several places, to give passage to its head-waters. The author insists, again, on the contrast between the extensive denudations which must have occurred in this district and the permanence of its surface, as attested by the preservation of the numerous Druidical and other British monuments scattered over these downs.

A little below Reading, the Thames (first having received another small tributary, the Loddon) quits for a time the London basin, to re-enter, by a sudden bend, another deep defile among the chalk hills, ranging by Henley and Marlow to Maidenhead, when it finally enters the plains of London. It is difficult to account for this deflection of the river, as a straighter course appears open to it by White Waltham to Bray. This line was surveyed for a canal by Mr. Brindley, and appears to be level to White Waltham, and thence to fall 47 feet to Mankey island, near Bray; so that a dam of a few feet across the river below Sunning at the mouth of the Loddon, would turn the waters into this channel. The author conceives the most natural mode of explaining this deflection of the river, is by the supposition that a higher range of tertiary strata once extended from the ridges of Bagshot-heath in this direction; forming a bar to the progress of the stream in this line.

V. The plains of London are covered with enormous accumulations of water-worn debris, chiefly of chalk-flints, and often abounding in fossil remains of elephants, hippopotami, &c.: the gravel is not confined to the low grounds, but caps the highest summits of the district; e. g. Highgate on the north, and Shooter's Hill on the south of the river. To explain this distribution of this gravel by the operation of the actual rivers, the author observes that it is necessary, first, to suppose that an uniform plane originally existed from the

summit of Highgate to the Hertfordshire chalk downs, and from the top of Shooter's Hill to those of Kent; on the surface of which the rivers once flowed. 2ndly, That these rivers have subsequently washed away all that immense mass of materials which would be requisite thus to reconstruct the surface; and 3rdly, That having worn down that surface into nearly its present form, the rivers perpetually shifted their channels so as to distribute the gravel equally over the whole plain of London, yet remained long enough in each channel to lodge there deposits of this gravel 20 or 30 feet thick.

A paper was also read entitled, "A few facts and observations as to the power which running water exerts in removing heavy bodies," by Matthew Culley, Esq., F.G.S., &c., in a letter to Roderick Impey Murchison, Esq., Sec. G.S., F.R.S., &c.

The heavy rains which fell during three days of August, 1827, swelled to an unusual height the small rivulet called the College, which flows at a moderate declivity from the eastern watershed of the Cheviot hills, and caused that stream not only to transport enormous accumulations of several thousand tons weight of gravel and sand to the plain of the Till, but also to carry away a bridge then in progress of building, some of the arch-stones of which, weighing from  $\frac{1}{2}$  to  $\frac{3}{4}$  of a ton each, were propelled two miles down the rivulet.

On the same occasion, the current tore away from the abutment of a mill-dam, a large block of greenstone-porphry, weighing nearly two tons, and transported the same to the distance of a quarter of a mile. Instances are related as occurring repeatedly, in which from one to three thousand tons of gravel are in like manner removed to great distances in one day; and the author asserts, that, whenever 400 or 500 cart-loads of this gravel are taken away for the repair of roads, one moderate flood replaces the amount of loss with the same quantity of rounded debris.

Parallel cases of the power of water are stated to occur in the Tweed, near Coldstream.

June 19.—A. B. De Capel Brooke, Esq., of Lower Brooke Street; James Morrison, Esq., of Portland Place; and Daniel Sharpe, Esq., of New Ormond Street,—were elected Fellows of this Society.

A paper "On the occurrence of agates in the dolomitic strata of the new-red-sandstone formation in the Mendip Hills," by the Rev. W. Buckland, D.D., V.P.G.S., F.R.S., &c., &c., was read. These agates are ploughed out of the surface of the fields at Sandford, near Banwell, and are nearly allied to the potatoe-stones, which abound in the new-red-sandstone formation that surrounds the Mendip Hills. Their prevailing colours are various shades of gray; their internal structure resembles that of the bird's-eye agate, presenting alternate bands of chalcedony, jasper, and hornstone, disposed in irregular and concentric curves: some specimens from Worle and Clevedon are of the nature of fine jasper agates, and of a bright red colour.

A shallow pit, from which the agates are extracted at Sandford, presents the following section.

- |  |   |           |
|--|---|-----------|
| 1. Yellow clay, mixed with magnesia and carbonate of lime..... | } | 6 inches. |
|--|---|-----------|

- |   |              |
|---|--------------|
| 2. Yellow dolomite, used as firestone in limekilns; it crumbles readily to a soft powder, and is filled with specks of manganese, and contains veins of small nodules of chalcedony.....                    | } 6 inches.  |
| 3. Yellow clay falling to powder, in water, like Fuller's earth, and containing much carbonate of lime and magnesia. In this clay the agates are dispersed irregularly like nodules of flint in chalk ..... |              |
| 4. Yellow clay and earthy dolomite, to the bottom of the pit .....  | } 12 inches. |

The author adduces a parallel example of beds and nodules of jasper and jasper-agate in the mountains of dolomite, near Palermo, in a formation of the same age with the new-red-sandstone of the Mendip Hills. He also gives examples of agates formed in cavities of chert of the green-sand formation, near Lyme Regis, and in cavities of silicified wood and silicified corals and shells. The most beautiful specimens of the two former are from the tertiary strata of Antigua. Shells converted into chalcedony, and containing agates in their cavities, occur near Exeter, in the whet-stone-pits of the green-sand formation, at Black Down Hill; and shells, entirely converted to red jasper, in sand of the same formation, at Little Haldon Hill.

A paper was next read "On the tertiary fresh-water formations of Aix in Provence, including the coal-field of Fuveau," by Roderick Impey Murchison, Esq., Sec. G.S., F.R.S., &c., and Charles Lyell, Esq., For. Sec. G.S., F.R.S., &c.; with a description of fossil insects contained therein, by John Curtis, Esq., F.L.S.

The oldest and fundamental rock of this district is a highly inclined and contorted secondary limestone, containing Belemnites, Gryphites and Terebratulæ; on which is unconformably deposited a vast fresh-water formation, the relations of which are shown in a section from N.E. to S.W.—The escarpment of white marl and limestone, N.E. of the town of Aix, is first described in descending series. The upper beds consisting of white calcareous marls and marlstone, calcareo-siliceous millstone and resinous flint, contain the *Potamides Lamarckii*, *Bulinus terebra* and *B. pygmeus*, with a new species of *Cyclas* named *C. gibbosa*, and the subjacent strata run out into a terrace, beneath which gypsum is extensively worked. Of these beds (minutely detailed), some are peculiarly characterized by their abundance of fossil fish; and others by a profusion of plants, amongst which, Mr. Lindley has recognised *Flabellaria Lamanonis* of M. Ad. Brongniart, and the leaves of *Laurus dulcis*? *Podocarpus macrophylla*? and *Buxus Balearica*?—the terminal pinna of a leguminous plant, referrible to *Loteæ* or *Phaseoleæ* of De Candolle, the branch of a *Thuya* nearly related to *T. articulata*, and what appears to be the fruit of some unknown plant, &c., &c. In this upper system of gypsum the fossil insects occur exclusively in a finely laminated bed of about 2 inches thick; and still lower are two other ranges of gypsum, the upper one of which alone is worked; and the marls associated therewith, contain nearly as great a quantity of fossil fish as those of the upper

zone. Beneath these are beds of white and pink-coloured marlstone and marl, inclined at  $25^{\circ}$  to  $30^{\circ}$ , and distinguished by *Potamides Lamarckii*, and a new species of *Cyclas*, named *C. Aquæ Sextiæ*, and these pass downwards into a red-sandstone (*Molasse*) and a coarse conglomerate (*Nagelfleu*), the town of Aix being situated at the base of the whole of the above series.

In continuing the sectional line to the S.W., all the district between Aix and Fuveau is made up of parallel ridges of fresh-water rocks; the most northerly containing red marl and fibrous gypsum, with *Limnææ* and *Planorbes* (*P. rotundatus*): the intermediate range is of mere earthy limestone, containing *Limnææ* and *Gyrogonites*, with micaceous sandstone and shale; and lastly, the coal-field of Fuveau is described as composed of gray, blue, and black compact limestone and shale, with stony bituminous coal of good quality; the united thickness of the different seams of which amounts to about 5 feet. The fossils characterizing the carboniferous strata are 2 new species of *Cyclas*, named *C. cuneata* and *C. concinna*, a *Melania*, named *M. scalaris*; *Planorbis cornu*, and a large species of *Unio*. Casts of *Gyrogonites* were observed even in the coal itself, and the charcoal seemed in some instances to be made up of a plant resembling *Endogenites bacillare* of Brongniart.

The authors remark that these lower members of this great tertiary deposit differ in character from any other fresh-water group examined by them in Central France, and have so much the aspect of the most ancient secondary rocks, that the presence alone of fluviatile and lacustrine shells, with *Gyrogonites*, compelled them to recognise the comparatively recent date of the whole group.

This notice was accompanied by observations on the fossil insects, mentioned in the preceding memoir, by John Curtis, Esq., F.L.S. These insects are all of European forms, and are most of them referrible to existing genera. The greater portions belong to the orders *Diptera* and *Hemiptera*; the *Coleoptera* are next in number, there are only a few *Hymenoptera*, and but one *Lepidopterous* insect. "As a larger collection," says Mr. Curtis, "might greatly change the proportion of the different orders, no positive inference, as to climate, should be drawn from the present assemblage; but there is nothing in the character of the insects to warrant the supposition of a higher temperature than that of the South of France." The great portion of these remains were very probably brought together from different localities by floods, mountain-torrents, or rivers; yet there is no insect among them that might not be found in a moist wood. The antennæ, tarsi, and other parts whereby the characters would be best distinguished, are often wanting; yet enough characters frequently remain even then to distinguish the genus. The sculpture, and even some degree of colouring, are preserved in several specimens. The wings of some beetles are extended beyond the elytra, showing that when they perished, they were flying or attempting to escape by flight.

A collection of fossil vegetables, from the Northumberland and Durham coal-field, was exhibited at this meeting, and presented to the

Society by William Hutton, Esq., of Newcastle-upon-Tyne, F.G.S.; with a catalogue describing the plants, according to the systems of M. Ad. Brongniart and Mr. Artis. The collection consisted of specimens of Calamites, Sagenaria, Filicites, Myriophyllites, Asteriophyllites and Sphænophyllites.

At the close of this Meeting, which terminated the session, the Society adjourned till Friday evening the 6th of November.

PROCEEDINGS  
OF  
THE GEOLOGICAL SOCIETY OF LONDON.

1829.

No. 13.

Nov. 6th, 1829.—The Society assembled this evening for the Session.

George Biddell Airy, Esq. M.A. Fellow of Trinity College, Cambridge, and Professor of Astronomy in that University; John Macpherson Grant, Esq. of Ballindalloch, N. B. and attached to His Majesty's Legation at Turin; John Heywood Hawkins, Esq. of Bignor Park, Sussex; Philip Duncan, Esq., Fellow of New College, Oxford; and William Cavendish, Esq., M.P. M.A. of Trinity College, Cambridge, and Belgrave-square London, were elected Fellows of this Society.

A Paper was read, "On the Tertiary Deposits of the Vale of Gosau in the Salzburg Alps; by the Rev. Adam Sedgwick, Pres. G.S. F.R.S. &c., and Roderick Impey Murchison, Esq. Sec. G.S. F.R.S. &c."

The authors present this as the first of a series of memoirs in which they hope to throw some light on the structure of the tertiary formations in Salzburg and Bavaria, and their varied relations to the secondary rocks of the Austrian Alps.

These deposits, the highest members of which descend into the flat regions near the banks of the Danube, become, in their lower groups, more elevated and more highly inclined; and, as they approach their southern or Alpine barrier, are sometimes vertical: whilst in the valley of Gosau and far within that barrier, formations with the same organic remains are found at much higher elevations, inclosed in Alpine limestone, on which they rest unconformably, and in a nearly horizontal position. This deposit of Gosau the authors conceive to have been formed in one of the arms of an ancient sea which, like the present salt-water lochs of Scotland, must have penetrated deeply into the then existing valleys of the Alps; whilst its actual position incontestably proves that it must have been prodigiously upheaved at some time posterior to the epoch of its formation.

In ascending the drainage of the Traun to the district under review, patches of these tertiary formations are described as occurring in various small transverse valleys between Gmunden and Ischel; but these are comparatively at low elevations, and all traces of them are lost in the higher regions between Ischel and the Lake of Hallstadt, which is about 1700 feet above the level of the sea. The valley of Gosau is described as situated more than five miles to the west of that lake and about 900 feet above its level. The formations which the authors consider Tertiary, occupy the flanks of this valley, and are chiefly exhibited in two hilly ranges, the Horn on the west,

and the Ressenberg on the east. The beds of these hills are nearly horizontal, have an estimated thickness of not less than 2600 feet, and are shut in on all sides by Alpine limestone, forming on the south a great serrated barrier, the highest pinnacles of which are more than 10,000 feet above the level of the sea.

The following abstract of detailed sections derived from the Horn and the Ressenberg, exhibits the strata in descending order.

1st. Red and green slaty micaceous sandstone, several hundred feet thick (cap of the Horn).

2nd. Green, micaceous, gritty sandstone extensively quarried as whetstone, succeeded by yellowish, sandy marls (Ressenberg).

3rd. A vast, shelly series consisting of blue marls alternating with strong beds of compact limestone and calcareous grit, the upper beds of which are marked by obscure traces of vegetables; and the middle and inferior strata, by a prodigious quantity of well preserved organic remains, out of which the authors collected upwards of eighty species of bivalve and univalve shells, and fifteen species of corals. (Localities :—beds of torrents descending into Gosau-Thal.)

4th. The above shelly series graduates downwards into beds of a more conglomerate form which pass into a red sandstone and marl containing gypsum; and a coarse conglomerate, forming the base of the whole system, rests upon, and abuts against, the Alpine or saliferous limestone. (Locality :—Russbach.)

Amongst the shells occurring in the group No. 3, are

*Bivalves* :—*Crassatella* 2 species, *Corbula* 1, *Pectunculus* 3, *Cardium* 3, *Plicatula* 2, *Gryphæa* 2, *Trigonia* 2, *Pecten* 1, *Solen* 1, *Anatina* 1, *Lucina* 1, *Astarte* 1, *Venus* 2, *Cypricardia* 1, *Isocardia* 1, *Ostrea* 2, *Hippurites* 2\*; &c. &c.

*Univalves* :—*Melania* 2, *Melanopsis* ? 1, *Ampullaria* 1, *Neretina* 1, *Natica* 3, *Trochus* 1, *Turbo* 1, *Turritella* 2, *Cerithium* 6, *Nerita* 2, *Turbinella* 1, *Fusus* 2, *Rostellaria* 1, *Buccinum* 3, *Mitra* 2, *Volvaria* 2, *Conus* ? 1, &c. &c.

*Corals* :—*Turbinolia* 1, *Caryophyllia* 3, *Fungia* 2, *Cyclolites* ? 2, *Astrea* 5, *Madrepora* 2.

The above organic remains have been examined by M. Deshayes and Mr. J. Sowerby, neither of whom detected a single species identical with any known fossil of the secondary rocks, whilst they consider the greater number of the genera to be eminently characteristic of the tertiary period.—The authors have further remarked a strong resemblance between these fossils and certain unpublished species of the Vicentino, and Mr. Sowerby has identified a few species with well-known tertiary shells. It is, therefore, concluded both from negative and positive zoological evidence, as well as from the unconformable position of the beds, that the whole deposit of Gosau must be considered tertiary, or, in other words, younger than the chalk. At the same time, the great proportion of new species contained therein, and the absence of those identifications with recent shells

\* The genus *Hippurites* is placed among the bivalves on the authority of M. Deshayes.



which mark the fossils of the younger tertiary groups, prove that it must be ranked with the most ancient deposits of that series.

In the basins which have been best examined, there is an entire break between the secondary and tertiary groups. But the great mechanical agents which in these localities have elevated and ground down the secondary rocks, before the commencement of the tertiary, may not have acted universally. There is therefore reason to expect in distant localities new groups of rocks by which this break may be filled up; and by help of which it will perhaps be found that the newest secondary rocks and the oldest tertiary, graduate finally into each other.

Nov. 20.—J. R. Gowen, Esq. of Highclere, near Newbury, and William Holbech, Esq. of Farnborough, Warwickshire, were elected Fellows of this Society.

The reading of a paper, "On the Tertiary Formations which range along the Flanks of the Salzburg and Bavarian Alps," being in continuation of the memoir "On the Valley of Gosau," by the Rev. Adam Sedgwick, Pres. G.S. F.R.S. &c., and Roderick Impey Murchison, Esq. Sec. G.S. F.R.S. &c. was begun.

Dec. 4.—Nicholas Dennys, Esq. of Cambridge Terrace, Regent's Park; John Willimott, Esq. of Jermyn-street, St. James's; William Higgins, Esq. of Coggeshall, Essex; and Edward Spencer, Esq., of Highgate, were elected Fellows of this Society.

His Imperial Highness the Arch-duke John of Austria; Professor Hausmann, of Göttingen; M. Hoffmann, of Berlin; M. Voltz, of Strasbourg; M. Dufrenoy, of Paris; and Dr. Ami Boué, were elected Foreign Members of the Society.

The reading of the paper by the Rev. Adam Sedgwick, Pres. G.S. F.R.S. &c., and Roderick Impey Murchison, Esq. Sec. G.S. F.R.S., &c. begun at the last meeting, was concluded.

The authors, having in a former communication described the great relations of the tertiary formations on the north flank of the Alps to the older part of the chain, proceed in this paper to confirm their conclusions by a series of detailed transverse sections, commencing with the hills near the foot of the Traunsee, and ending with the lofty hills of molasse and conglomerate near the Lake of Bregenz.

1. *Section at the foot of the Traunsee.*—The tertiary formations here commence on the north side of the Traunstein; and the lower beds are described as being chiefly argillaceous, of a great thickness, and in a highly inclined position. They contain some of the Gosau fossils, and in their prolongation form the base of a hill 1800 feet high, composed of alternating beds of sandstone and of sandy marl. This whole system is surmounted by great alternating masses of conglomerate, sandstone, and marl, forming a succession of parallel ridges in the country north of Gmunden; and still further towards the north, and in a higher part of the series, are beds of lignite.

2. *Section of Salzburg.*—Great parallel ridges of conglomerate and sandstone extend at the foot of the higher Alps, from the denudation of the Traun to that of the Salza. The conglomerates resting immediately on the older limestone, re-appear on the left bank of

the river, and form a mural precipice on the S.W. side of the city of Salzburg. They are described in detail, and are shown to have originated in the mechanical degradation of the neighbouring chain; and having a high inclination which carries them under the micaceous sandstones of the northern plains, are, on that account, referred to the lower part of the tertiary system.

3. *Section from Untersberg to the plains N.E. of Reichenhall.*—The authors here give a short account of the great secondary system of Alpine limestone; and the Untersberg beds, which contain innumerable Hippurites, are shown to belong to the highest part of that series. Over the Untersberg beds, the section exhibits the following succession.

a. A great deposit of marl and marlstone, generally of a gray, but in some places of a red colour; containing a few fossils resembling those of the chalk formation.

b. Sandy, micaceous marls alternating with conglomerates and micaceous, calc-grit, with Nummulites. Subordinate to this system are red and variegated marls, with gypsum.

c. A system of beds composed of blue, micaceous slate-clay and greenish, micaceous sandstone.

d. A great succession of alternating masses of blueish, micaceous marl, slate-clay, sandstone, and conglomerate. Some of these upper marls contain beds of gypsum and fossils, resembling the suite of Gosau. The whole of the preceding series is succeeded towards the north by the tertiary, slaty, green sandstone of the plains.

As all the deposits above described are conformable to each other, there is a difficulty in drawing the precise line of demarcation between the secondary and tertiary formations: the authors (though not without some hesitation) place the nummulite-rock, which is associated with the lower gypseous marls, at the base of the tertiary group.

4. *Section from the Stauffenberg, through the Kachelstein and the Kressenberg, towards the plains of Bavaria.*—In this section the Stauffenberg and the Kachelstein belong to the outer zone of secondary Alpine limestone, which in this region is enormously dislocated, so that the subordinate beds are not only contorted and pitched up at high angles, but generally plunge in towards the axis of the chain. The Kressenberg rises to the height of 500 or 600 feet on the north side of the Kachelstein, and forms a gradual slope towards the northern plains. Its subordinate beds dip at high angles of elevation towards the south, those which are nearest the secondary ridges being inclined at 80°. This position gives the system of the Kressenberg the appearance of dipping under the secondary rocks, an appearance which the authors consider entirely deceptive, and for which they account by the intervention of a great fault. They consider the beds of the Kressenberg hills as tertiary; because, though inclined in the same general direction with the secondary mountains, they are not conformable to them; because they contain no Ammonites, Belemnites, or other secondary fossils; and, lastly, because they contain very many organic remains which characterise tertiary formations. The authors here

refer to the list of fossils derived by Count Munster from this locality, and they entirely coincide with the opinions which he has published respecting them. This tertiary system is almost entirely composed of sand and sandstone which, here and there, contain many particles of green earth, in some places resembling tertiary molasse, and in others not to be distinguished from secondary, green sand. Subordinate to this system are eleven beds of granular hydrate of iron (varying from five to seven feet in thickness), which are extensively worked.

After the details of the preceding section, the great derangements of the neighbouring Alpine chain are briefly noticed. It is shown that there are two anticlinal lines; one of which ranges through the mineralogical centre of the chain; while the other, passing longitudinally through the great calcareous zone appears to carry a part of the saliferous series under the older formations.

5. *Tertiary deposits in the Valley of the Inn.*—These were probably once of considerable extent, occupying a basin about twenty miles in length, but not more than three or four miles in its greatest breadth. They are now chiefly seen near Häring, where a bed of coal thirty-four feet in thickness is extensively worked by means of long horizontal levels, which traverse a great succession of strata. These beds are described in great detail, and are principally composed of fetid marls in various states of induration. The coal and overlying beds contain many land and fluviatile shells, and have at first sight the appearance of a great lacustrine formation. Some of the beds above the coal, contain innumerable impressions of well-preserved dicotyledonous and other plants, many of which are in the course of examination by M. Adolphe Brongniart. There are, however, several marine shells in the strata, which show that the sea ascended up this part of the valley of the Inn during the period of the Häring deposit. From the general character of these marine shells, some of which have been identified with those of the London clay, the authors are disposed to refer the whole deposit to an early part of the tertiary period.

6. *Sections of the tertiary formations of Bavaria.*—The authors first remark, that the line of demarcation between the secondary and tertiary groups, is generally well defined; but they also derive from this region several proofs that the tertiary seas ascended up the old valleys of the Alps a long way to the south of the average direction of this line. In proof of this they refer to some deposits in the valley of the Isar. They then describe in detail the sections between Füssen and Schöngau, in which an enormous succession of beds is laid bare on the banks of the Lech.

They afterwards describe the section of Nesselwang, in which the lowest strata of the tertiary series are of great thickness, and are raised against the side of the Alps in a vertical position. They remark that the tertiary system has here a coarser structure than in most parts of the range; that beds of conglomerate abound in the lower part of it; and that the beds of molasse and marl are entirely subordinate to them. Lastly, the authors remark no less

than three or four distinct zones of coal or lignite, separated from each other by sedimentary deposits of enormous thickness; as some of these zones occur in the lower, and some in the higher parts of the tertiary group, they infer that the existence of lignite is, of itself, no general test of the age of a tertiary deposit.

7. *Section through the hills at the east end of the Lake of Constance.*—After making some remarks upon the great elevation of the tertiary formations in the south-western extremity of Bavaria, the authors proceed to describe the transverse section exhibited by the hills above Bregenz. They commence with a description of the nummulite-rocks of Haslach, which are associated with, and form a prolongation of, the secondary system of the Stauffen and the Salzburg chain. They also refer the nummulite-rocks and marl-slate above Oberdorf to the same system, and compare them with the nummulite-ironstone of Sonthofen. In consequence of the derangement of the strata, and the accumulations of transported materials, the first commencement of the tertiary beds is obscure; but they rise into hills of the elevation of about 2500 feet above the Lake of Constance, and mark the prolongation of the secondary series, on the northern extremity of a ridge called Rexberg, ten or twelve miles S. E. of Bregenz. The lower part of the tertiary system, is composed of green, micaceous sandstone, to which certain beds of conglomerate are subordinate, and it is described as perfectly identical with the great deposit of adjoining molasse which forms the base of the tertiary formations of Switzerland. This sandstone occupies the successive ridges which extend from the neighbourhood of Oberdorf to Bregenz. And, as in the greater part of this long range the beds are highly inclined and have an undeviating dip towards the north, their united thickness must be enormously great.—The authors afterwards describe, with many details, the great complex deposit of conglomerates alternating with greenish sandstone and variously coloured marls which constitute the upper tertiary group, and compose the whole mass of the mountain ridge extending northwards from Bregenz. This whole section is considered of importance, partly from the great scale upon which the formation is developed, and still more from its forming a connecting link between the tertiary deposits or molasse of Switzerland and those which are exhibited in the several sections described in this paper.

Finally, the authors give a short summary of the conclusions which seem to follow from the facts stated in the memoir.

1. The tertiary formations of Austria and Bavaria appear to have been formed in an ancient mediterranean sea, the limits of which may be in a considerable measure ascertained; and the great mechanical deposits above described seem to have originated in the gradual degradation of the Alpine chain, partly by the action of the sea on the flanks, and partly by the erosion of the torrents descending from the mountains, and carrying great masses of transported materials below the level of the waters.

2. In some instances the tertiary beds are unconformable to the

Alpine limestone; in other instances they are conformable. And there are beds which, both from their fossils and from their structure, seem to exhibit a connecting link between the secondary and tertiary formations.

3. The system above described contains three or four distinct zones of coal or lignite, with many thousand feet of conglomerate, sandstone and marl between each; beginning in the lower, and ending in the upper parts of the series.

4. These younger deposits have the same general relations to the older chain, as the subalpine tertiary formations of the north of Italy; from which it seems to follow that the northern and western basins of the Danube, and the tertiary basin of the subalpine and sub-apennine regions, must have been left dry at the same period. The conclusion is further confirmed by the suite of fossils in the adjoining molasse of Switzerland.

5. All the transverse sections prove the recent longitudinal elevation of the neighbouring chain. The tertiary beds form an inclined plane, down which the Alpine waters stream into the Danube in nearly undeviating lines, greatly contrasted with the sinuous channels through which the waters escape into the plains from the older rocks.

6. The authors endeavour to confirm the preceding conclusion by the facts exhibited in the drainage of the south of Bavaria. They state that the whole system of drainage, is in a state of continual change and of progress, and that the rivers have not yet worked for themselves any thing like permanent channels.

7. The authors lastly account for some of the greater denudations, by debacles which must have taken place during the elevation of the Alps, and by the bursting of a succession of lakes since that period. In confirmation of which, they state that there is not a single valley among the newer formations of southern Bavaria, in which may not be seen many parallel terraces (like the parallel roads of Scotland) indicating the residence of nearly stagnant water at several successive levels.

A paper "On the discovery of the bones of the *Iguanodon*, and other large reptiles, in the Isle of Wight and Isle of Purbeck; by the Rev. William Buckland, D.D. V.P.G.S. F.R.S. &c. &c.," was then read.

Hitherto the *Iguanodon* has been found only within the limits of the Weald of Sussex, where it was first discovered by Mr. Mantell, in the iron sandstone formation of Tilgate Forest. Dr. Buckland has recently ascertained the existence of this animal in two other localities of the same formation: one near Sandown Fort on the south coast of the Isle of Wight; the other in Swanwich Bay, at the eastern extremity of the Isle of Purbeck. In all these places its matrix is the same, ferruginous sandstone, to which the name of Wealden or Hastings sandstone, has been applied by recent observers in geology, being intermediate between the lowest beds of the green sand formation and the upper beds of the Purbeck limestone, and its fossil shells exhibiting such an admixture of marine

remains with those of freshwater, as seems to indicate the former existence of a great estuary in the district wherein they have been deposited.

From the size of the bones of the Iguanodon, described by Mr. Mantell and Mr. Murchison\*, it has been ascertained that this herbivorous reptile was of extraordinary magnitude; but a single bone of its foot has been lately found near Sandown Fort, which shows that its proportions probably exceeded those of the most gigantic quadruped yet discovered. The bone alluded to seems to be the external metacarpal bone of the right foot; it is twice as large as the corresponding bone of a large elephant; its length is six inches, its breadth at the upper extremity five inches, and its weight six pounds. A gigantic pelvis was also found in the same iron-sand at Sandown Fort. Among the bones discovered in the Isle of Purbeck by the Rev. J. C. Bartlett, the most remarkable are large vertebræ, and toe bones of the Iguanodon, in size and form resembling those engraved by Mr. Mantell from Tilgate Forest; there are also various bones of other species of reptiles; a fragment of a femur, resembling that of the Megalosaurus; bones of large and small Crocodiles, and of more than one species of Plesiosaurus. All these animals have been found by Mr. Mantell, similarly associated in the Hastings sandstone of Tilgate Forest. Dr. Fitton has ascertained the shells in this iron-sand at Swanwich and Sandown Fort to be identical with those of the same formation in the Weald†; and the addition of so many reptiles to the list of their common organic remains, affords still further evidence of the identity of the strata in which they occur.

\* See Mantell, Tilgate Forest; and Geol. Trans. vol. ii. 2nd Series.

† See Annals of Philosophy, Nov. 1824.

PROCEEDINGS  
OF  
THE GEOLOGICAL SOCIETY OF LONDON.

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1829-1830.

No. 14.

Dec. 18:—Benjamin Blake, Esq. Captain in the Bengal Army; Matthias Attwood, Esq., M.P., of Gracechurch-street, London, and Muswell-hill, Middlesex; James Hall, Esq. of Southampton-street, Russell-square; and Thomas Clement Sneyd Kynnersley, Esq. of Essex-court, Temple,—were elected Fellows of this Society.

M. J. J. D'Omalius D'Hallo, &c. &c. Governor of the Province of Namur, in the kingdom of the Netherlands, was elected a Foreign Member of this Society.

A paper was read entitled "Observations on part of the Low Countries and the north of France, principally near Maestricht and Aix-la-Chapelle;" by William Henry Fitton, M.D. F.G.S. &c.—The general structure of the country on the confines of the Netherlands and France has been described, several years ago, by M. D'Omalius D'Hallo; and various memoirs, since published by other persons, confirm his statements. The basis of the whole tract consists of the coal-measures, with subjacent shale, grit, mountain-limestone, reddish sandstone and conglomerate, and finally transition-slate. Above this series of highly inclined beds, other strata, unconformable and nearly horizontal, repose; which, in the Boullonois, include the upper part of the oolitic groups; but, in advancing eastward, descend no lower than the green-sands. The country therefore is analogous to the vicinity of Bristol and Bath; but the overlying formations there go down to the lower oolite, lias, and new red sandstone.

The object of the author's inquiries was, to determine what beds are found, in the tract which he examined, above the coal; and how far they agree with their equivalents in England. He describes in succession the several strata: the list including, in a descending order,—1. Beds above the chalk;—to which are referred,—2. The stone and calcareous sands of Maestricht.—3. White chalk, passing into the Green-sand formation,—which comprehends,—4. Firestone, with—5. Green and ferruginous sands.—6. Obscure traces of clays beneath the sands. The whole being unconformable and superior to—7. The coal-measures, &c. &c.—The paper is accompanied by lists of the fossils, examined and named by Mr. Sowerby; and by a sketch of a general map, with sections on a larger scale.

1. *Beds above the chalk.*—The Crag, of Suffolk, &c. is stated, on the authority of Mr. Warburton, to have been observed on the French coast between Calais and Cape Blanc-Nez; near Antwerp; in the neighbourhood of Tongres; and at other places in the Netherlands. The fossils also of Klein-Spawen between, Tongres and Maestricht, include, along with several shells of the calcaire-grossier, some of those found in our crag.

The sands which immediately precede the chalk, along the road

from London to Dover, precisely resemble those in the same situation, on the line from Calais through St. Omer, Cassel, and Lille, &c.: the prominent hill of Cassel, however, is not topped with clay, but seems to consist entirely of sand, including very numerous fossils, contained principally in loose concretionary beds of stone. These fossils, many of which are the same with those of similar sands near Brussels, agree, in general, with those of the London-clay; and thence it would appear, that the separation of that stratum from the sands immediately incumbent on the chalk is not well founded. Beds of the sands here referred to occur, in the same geological place, in Kent; near St. Omer; at Cassel; at Mount-Panisel, and Ciply, south of Mons; at Brussels; between Charleroi and Fleurus; and at Kleyn-Spauwen, between Tongres and Maestricht.

2. *Maestricht stratum*.—Between the deposition of the sands last mentioned and of the chalk, a considerable interval must have elapsed; during which various beds may have been deposited, of which no trace, or but obscure remains exist, at present, in England. The well-known stratum of St. Peter's-Mount near Maestricht is one of these: it is throughout superior to the white chalk, into which it passes gradually below, but the top bears marks of devastation, and there is no passage from it to the sands above. The siliceous masses which it includes are much more rare than those of the chalk, of greater bulk, and not composed of black flint, but of a stone approaching to chert, and, in some cases, to calcedony:—and of about fifty species of its fossils in the author's collection, about forty are not found in Mr. Mantell's catalogue of the chalk fossils of Sussex\*. The author therefore, with Mr. Hony†, and Mr. Conybeare‡, regards this bed as differing from, though intimately connected with the chalk.

A very fine section of the Maestricht bed is visible on the sides of the valleys of the Meuse and of the Jaar; and in the heights opposite to Visé the bed, gradually rising from Maestricht, disappears, and is succeeded by white chalk with flints. The section of this stratum, and all the accompanying circumstances, at Ciply, south of Mons, accord remarkably with those of Maestricht; and from M. Desnoyer's statements, a bed of the same description seems to exist also in the Cotentin.

3. *Chalk*.—The thickness of this stratum in the Netherlands is much less than on the coasts of the Channel; especially of the part containing flints, which is succeeded, in descending, by chalk without flints, passing into marl, and thence into fire-stone and green-sand. The white chalk is well seen at Wonck and Heur le Romain opposite to Visé; and, on the north of Aix-la-Chapelle, a remarkable group, which the author refers to the lower part of the chalk, consists of hard beds of grey and cream-coloured limestone, alternating with calcareous sand. This stratum, which abounds in fossils, many of them belonging to the lower chalk of England, has been found at a considerable depth at Cawenberg on the north-west of Maes-

\* Geol. Trans. 2d Series, III. 201.

† Geol. Trans. II. 310.

‡ Outlines, p. 63.



tricht ; it is prominent in the well-known quarries of Cunroot, on the east of Fauquemont, and caps the heights on the north-west of Aix-la-Chapelle, from Schneeberg to the west of Laurensberg ; a small outlying portion remaining also on the top of the Louisberg, near Aix. A stratum like this is mentioned by Mr. Forschammer as occurring in a similar place below the chalk of Denmark, on the shores of the Baltic ; and seems also to exist in the Cotentin.

4. *Green-sand formation.*—The marly chalk is succeeded by the equivalent of our upper green-sand, or fire-stone (the *Pläner-kalk* of Germany), in some places identical with that of Surrey, Kent, and Wilts ; and like that stone is employed exclusively in constructing the interior of furnaces and buildings under water ; extensive quarries for these purposes being worked at Königsberg opposite to Vael, on the confines of the Prussian and Dutch territories. In this country however, there is not, beneath the fire-stone, (or at least does not distinctly appear,) a stratum of clay, like our gault ; but the chalk, becoming gradually charged with green particles, passes, in general without an intermediate valley, into green and ferruginous sands, obviously analogous to the lower green (or Shanklin) sands of England.

5. These sands are well exhibited in the hills on the south-west of Aix-la-Chapelle, and, extending beyond the chalk, occupy a large portion of the surface above the coal and mountain-limestone country. Distinct sections of the stratum are seen on the sides of Louisberg close to Aix, and along the road from that city to Liege,—the scenery of which resembles that of the Woburn sand-hills ; and on the descent towards the Calamine Works, near Moresnet, beds are found in the sand, analogous to the fuller's earth of Woburn and of Nutfield in Surrey. The fossils which abound in this formation include (along with many species common to them and the superior beds, and hitherto not found in England) some species almost characteristic of our lower green-sand ; among which may be mentioned the *Trigonia aliformis*, and *Rostellaria Parkinsoni*. The sands, at the Louisberg, include a thin bed of lignite ; and near the bottom of the formation at Gemenich, and thence along the foot of the hills to Eynatten, a remarkable stratum of grit from 6 to 10 feet in thickness, of great firmness and uniformity, occurs,—resembling in its characters the grey-wether stone of England, &c. and possibly the equivalent of some of those beds of conglomerate which occur in our green-sand, (the Bargate stone of Surrey, &c.) though differing from them in external character. The ferruginous sands of Grafenberg and other hills on the east of Dusseldorf, belong also to this formation, containing the same fossils as at Aix-la-Chapelle, and occupying a similar unconformable position above beds of limestone ; a striking section of which is visible on the banks of the Dussel, at Neanders-Höhle. The sands extending from thence to the north and eastward into Germany, are there well known under the denomination of Quader-sandstein.

6. In some places, the more ancient strata come in beneath the green-sands without any intervention ; in others, there are indications of intermediate beds of clay, but too indistinct to admit of ascertaining their relations.

7. The coal-formation and other subjacent beds are not considered in the present paper; the author referring for an account of them to the works of local geology already published or in progress; and to the paper on the Environs of Bristol, by Messrs. Buckland and Conybeare, (Geol. Trans. 2nd series, vol. i.) for a description of the analogous portions of England, which may perhaps remove some of the difficulties connected with the corresponding formations in the Low Countries.

The chief points of difference then, between the formations above referred to and their equivalents in England, are—1. The apparent identity of the fossils in the sands above the chalk, with those which appear in the clay of London.—2. The Maestricht stratum, distinctly superior to the chalk, and differing from that bed in its fossils and other characters, is without any equivalent yet ascertained in this country; but some facts are mentioned, which show that the former existence of such a stratum above our chalk is not improbable, and that further traces of it may still be discovered upon sufficient search.—3. The hard beds (of Cunroot, &c.) form a remarkable feature of the lower chalk in the country above described.—4. The absence or indistinctness of the gault, is one of the principal circumstances distinguishing the green-sand formation from ours; and the want of a valley, like that which commonly exists in this country along the foot of our chalk-hills, is an important difference of external feature.—5. The entire absence of the formations which, in the south-east of England, succeed the green-sand (the Weald clay, Hastings sands, and Purbeck strata), deserves also to be mentioned; for, of these beds, though so fully developed on our coast, none have yet been distinctly recognised upon the Continent, and traces only detected in the interior of England and in the lower Boulonnais.

In conclusion, the author remarks upon the great diversity of the upper and unconformable formations which, in different places, are in immediate contact with the older and inclined strata beneath. In some cases (as near Bristol) the red marl, lias, and lower oolite;—in others (lower Boulonnais) the upper oolite; in others still, the green-sands, the gault, and even the chalk itself,—are in contact with the coal strata. It may be difficult to explain the cause of this variation, and to account for the absence of the beds which are wanting; for the upper formations bear no obvious marks of disturbance, and are generally horizontal or very little inclined.

Jan. 1, 1830.—The Rev. Henry Coddington, of Trinity College, Cambridge, was elected a Fellow.

A paper was read, "On the Geology of the shores of the Gulf of La Spezia;" by Henry Thomas De la Beche, Esq. F.G.S. F.R.S. &c.

The chief objects of this memoir are to show,

1st. That the marbles of Porto Venere, although possessing some of the characters of transition rocks, may be the equivalents of part of the oolitic series.

2nd. That the diallage rock and serpentine of Southern Liguria have been protruded through the former at a period later than their formation.

Previous to his description of the geological structure of the di-

strict, the author gives a short sketch of its physical outline and superficial covering. The Alpi Appuani, or mountains of Massa and Carrara, form a distinct group, being separated from the main range of the Apennines, by a considerable depression, and from the hills of La Spezia by a plain through which the Magra flows. The plain is covered by gravel rising to some height above the Mediterranean. Of this gravel the banks of the Frigido afford a good section. Near Ponzo, between La Spezia and Borghetto, a torrent cuts through a hill composed of large rounded boulders and gravel, the coherence of which is trifling. These boulders could not have been produced by any causes at present existing in the district. The boulders are carried down the bed of the torrent but a short distance beyond the places where they occur as component parts of the hills. In the bed of the Vara, into which this torrent flows, there is gravel of the usual size, which may have been formed, and afterwards cut through, by the river.

*Stratified Rocks.*—1. *a.* Lignite, clay, sandstone and conglomerate, are described as being seen in vertical strata at Caniparola, near Sarzana, the shaly beds containing *Fucoides intricatus* (Ad. Brongn.), and the conglomerate being made up of compact limestone, macigno sandstone, and jasper, cemented by clay. These tertiary beds are supposed to have been thrown into their present vertical position by the forces which elevated the adjoining Alpi Appuani.

1. *b.* Breccia, with a porous limestone cement, is one of the youngest rocks in the gulf of La Spezia, where it occurs in promontories, and caps some of the cliffs:—from its resemblance to the rauchwacke of the zechstein, it has been erroneously referred to that formation.

1. *c.* Siliceous sandstone is connected with the breccia above mentioned, with which it is associated in contorted beds at St. Terenzo. The author does not pronounce positively upon the relative ages of the rocks of this group, although he asserts that they are all younger than the macigno.

2. *Macigno.*—Two sandstones of somewhat the same mineralogical structure, but of very different age, are comprehended under this name by the Italians; but the author here restricts the term to that which is highest in the order. The macigno is a brown and gray sandstone, both calcareous and siliceous, generally micaceous, with black specks, and is occasionally mixed with shale. It occurs near the Bagni di Lucca overlying gray compact limestone, which ranges from thence into the district under consideration, and has similar relations near Massa and Carrara, details and diagrams of which are given; it is also much developed north of La Spezia, and on the right bank of the Magra. In the absence of organic remains, the author has not been enabled to decide upon the equivalent of this rock.

3. *Gray compact limestone or Porto Venere marble.*—At La Spezia this group consists of, 1. Dark gray, black and yellow limestones, interstratified with schists and argillaceous slates; 2. Dolomite; 3. Dark gray compact limestone in thin beds; 4. Ditto with brown shale, and containing *Orthoceras*, *Ammonites*, *Belemnites*, and round balls of iron pyrites; 5 and 6. Shale, with compact thin-bedded limestone,

resembling that of the Jura. The islands of Tino and Palmaria are composed of this system, whence it rises into the high land of La Castellana, and extends to Pignone, forming the mountains of Coregna, Santa Croce, Parodi, and Bergamo. The dolomite occupying the centre of this range presents the appearance either of an included bed, or of a great dyke which throws off the strata on each side. The fossils of Coregna collected by the author (first noticed by Guidoni) are,

*Orthoceras* :—A species resembling *O. elongatum* of the lias, and also *O. Steinhaueri* of the coal measures.

*Belemnites* (many alveoli of).

*Ammonites* :—15 species, one of which is the *A. erugatus* of the Yorkshire lias (Phillips's Geol. of Yorkshire); and another resembles *A. Bucklandi*; whilst two are fossils of the coal-measures, viz. *A. Listeri* and *A. biformis*. The remainder are undescribed, but have been drawn by Mr. J. Sowerby to illustrate this memoir. From the nature of these organic remains, and principally from the presence of belemnites, the author, whilst admitting the conflicting nature of the evidence, similar to that observed in parts of the Alps described by M. Elie de Beaumont, inclines to the belief that this range of limestone, &c. is equivalent to the lias or some member of the oolitic series.

4. Brown shale and variegated beds are seen beneath the gray limestone; and again, below the variegated strata, there is a considerable developement of brown sandstone and gray schist, which constitutes a high range extending from La Castellana to beyond Vernazza, wherein a large *Fucus* is found. This gray schist at Monte Rosso seems to have been penetrated by diallage and serpentine rocks.

*Saccharine limestone, &c. of Capo Corvo*.—The coast section of Capo Corvo exhibits thick and thin beds of gray limestone alternating with schists; a thick-bedded fine conglomerate which passes into chlorite and micaceous schists; and saccharine limestone of various colours with mica schist; the whole in highly inclined and contorted positions. Similar rocks occur between the mouth of the Magra and Ameglia, where they are covered by the gray limestone, and contain a subordinate conglomerate very much resembling that of the Valorsine. The author is disposed to refer this group to the same age as the older conglomerates which occur between the high Alps and their calcareous zones on the side of Italy.

*Carrara Marbles*.—These seem to form part of the system of gneiss and mica schist of the adjoining Alpi Appuani, being distinctly stratified and underlying the gray limestone, resembling that of Porto Venere.

Gneiss and mica schist are well exposed in the valley of the Frigido near Massa.

*Unstratified Rocks: Diallage Rock and Serpentine*.—The author observed no traces of stratification in these rocks throughout Southern Liguria, and he coincides with the views of those who consider them to have had an igneous origin. In the Valley of Cravignola serpentine and diallage rock traverse gray limestone and schist, and in one part are in contact with jasper rock, which, as is noticed by M. Bron-

gniart, rests upon contorted limestone and schist. Between Monte Rosso and Vernazza the schists are much disturbed, and near Capo Mesco, and again at Levanto, diallage rock and serpentine passing into each other are protruded from beneath highly inclined beds of sandstone, in which are also many faults. These serpentine rocks seem to be prolongations of the great development of the same system in Southern Liguria; and, to illustrate more fully their nature, the author gives a section of their relations in a contiguous district at Monte Ferrato, where, as has already been noticed by M. Brongniart, gray compact limestone and slaty shale and jasper are covered by serpentine and diallage rocks, which, in one place, seem to traverse and cut through the strata.

In conclusion, the author observes, that if the Porto Venere marbles be considered equivalent to any part of the oolite formation, they afford a striking example of the little value of mineralogical structure as a character taken by itself, and show the extreme caution that should be used in assigning names to rocks from hand specimens, brought home by distant expeditions, without the accompaniment of organic remains. He considers that the diallage rock and serpentine of Southern Liguria, have been intruded among these rocks subsequent to the epoch of the oolite formation; and regards the diallage rock and serpentine as of igneous origin, concurring in opinion with those geologists who attribute to these rocks in common with granite and trap, and the forces that ejected them, the contortion and fracture of the stratified rocks, and their consequent elevation into ridges and mountains.

Jan. 15.—William Parker, Esq. of Albany-street, Regent's Park; and the Rev. H. P. Hamilton, of Trinity College, Cambridge, were elected Fellows of this Society.

A paper was read, entitled "On the Fossil Fox of Ceningen, with an account of the Lacustrine Deposit in which it was found," by R. I. Murchison, Esq. Sec. G.S. F.R.S. &c.

The author visiting Ceningen in 1828, acquired among other organic remains a perfect skeleton of a carnivorous quadruped, imbedded in a layer of slaty limestone, and the specific character of which has since been ascertained through the scientific labours of Mr. Mantell.

A short account is given of the works of the various authors who have described the fossils of Ceningen, from the time of Scheuchzer to that of Karg. Cuvier, however, is mentioned as the first who gave true specific characters to the vertebrated animals of this formation, and who ascertained that all the mammalia hitherto discovered in it were "Rodentia."

The author differing in opinion from an eminent French geologist, who has described this deposit as subordinate to the molasse, proceeds to show that the formation is exclusively lacustrine; and in proof of this, he offers, 1st, a description of the deposit, and its relations to the surrounding country; and 2ndly, a sketch of the organic remains.

Ceningen is situated about midway between Constance and Schaffhausen, on the right bank of the Rhine, where that river traverses the tertiary marine formation of molasse. This formation is here covered by patches of marl and limestone, which extend over the space of two or three miles, and are now well exposed in several quarries, the lowest of which is two hundred, and the highest six hundred feet above the Rhine, and in all of them are found organic remains, exclusively freshwater and terrestrial. The lower, or Wangen quarries, consist of light-coloured, sandy marlstones, divided from each other by thin layers of brown marl, and white slaty limestone, in which leaves of dicotyledonous plants, fishes, &c. are not unfrequent. The upper quarries offer a section nearly thirty feet deep, and are worked for the extraction of building-stone and limestone. A detail of the beds is given, which shows a passage downwards, from brown clay into cream-coloured, indurated marl, and afterwards into a fissile, fetid, marlstone, containing flattened shells of *Planorbes*, small *Lymnei*, &c., and *Cypris* : to these succeed light-coloured, fetid, calcareous, building-stone ; beneath which is a finely laminated bed containing insects, *Cypris*, shells of *Anodon*, and many plants : then follow two thin bands of fetid limestone, in the uppermost of which a large tortoise has been found, and in the lower was discovered the carnivorous quadruped. Both these animals were in positions which show that their remains had not been disturbed since they first sank down into the silt of the lake. The succeeding strata consist of slaty marl, several bands of slaty marlstone, limestone, and strong-bedded building-stone, with a repetition of finely laminated layers of marl, including plants and fishes, after which the incoherent sandstone of the molasse is reached, and forms the base of the quarry.

A description of the fossil quadruped is then given by Mr. Mantell, who has ascertained its specific character, by first clearing away the surrounding matrix, and afterwards comparing the skeleton with those of many varieties of the fox. He has no hesitation in referring the animal to the genus *Vulpes* ; but a difficulty occurs in positively assigning to it a specific character, owing to the compressed state of the head, which prevents the true form of the frontal bone and post-orbital apophyses from being determined. After noticing this and some slight variations of structure, which he is of opinion are insufficient to establish a variety, much less a species, he concludes that the animal bears a closer analogy to *Vulpes communis* than to any other species with which it has been compared.

The author proceeds to remark upon the existence beneath the lumbar vertebræ of the fossil fæces of the quadruped, which on being analysed by Dr. Prout, afforded the same proportion of phosphate of lime as the *Coprolites* described by Dr. Buckland. In this case, however, the whole of the adjoining rock is impregnated, though in a less degree, with phosphate of lime ; thus affording a strong presumption that the bituminization of the marlstone is due to the decomposition of the vast quantity of animal matter contained in it. All the other quadrupeds occurring at Ceningen have proved

to be Rodentia: amongst which, the *Anoema Ceningensis* has lately been figured by Mr. König; and a *Lagomys* was this year found by Professor Sedgwick and the author in a second visit to the quarries.

A synopsis follows of many of the birds, fishes, reptiles, insects, &c. In the insects there is a strong accordance in generic characters to those now inhabiting the district. Mr. Curtis recognizes Formicidæ and Hymenopteræ. Mr. Samouelle has noticed larva of *Libellula* similar to our common English species *Libellula depressa*, also the genera *Anthrax*, *Cimex*, *Coccinella*, *Cerambyx*, *Blatta*, and *Nepa*, some of which are known to feed upon such plants as we here find them associated with in their fossil state, and others are well known inhabitants of stagnant pools.

Of the numerous plants, the few the author collected have been examined by Mr. Lindley, who considers one to be undistinguishable from the recent *Fraxinus rotundifolia*, others strongly to resemble *Acer opulifolium* and *A. pseudoplatanus*; and a specimen of the leaf of an extinct poplar, remarkable for its form, has been named by him *Populus cordifolia*.

In conclusion the author infers,

1st, That the deposit of Ceningen is of purely lacustrine origin, and that its formation must have occupied a protracted period.

2ndly, That the tertiary marine formation of the molasse, was deeply excavated before the lacustrine accumulation commenced.

3rdly, That, from the intermixture of species undistinguishable from those now existing, with others which are decidedly extinct, this deposit must be considered one of those instructive examples which exhibit a gradual passage from an ancient state of nature to that which now prevails.

4thly, That, as it differs in most of its organic remains from all the fresh-water formations hitherto described, either near to, or remote from it, it must have been an independent deposit; and judging from its fossils and superposition to the molasse, it must have been of recent origin.

5thly, That recent as its origin may have been, the lacustrine basin has since been re-excavated to a great depth through horizontal strata of limestone, the highest of which are still seen six hundred feet above the present bed of the Rhine.

6thly, That although the deposit must have been formed long before the Rhine occupied its present level, the organic remains indicate, that even in those days there were insects, fishes, and plants almost identical with our own; and that among the quadrupeds there existed one, undistinguishable from the common fox now inhabiting our latitudes.

Feb. 5.—James Calder, Esq. of Calcutta, and Edward Johnstone, Esq., of Trinity College, Cambridge, were elected Fellows of this Society.

A letter addressed to the Secretary, R. I. Murchison, Esq. F.R.S. "On the animal remains found in the Transition Limestone of Plymouth," by the Rev. Richard Hennah, F.G.S. was read.

This is the last of a series of communications by the author on the same subject; and in this he endeavours to classify all the organic remains found by him in the Plymouth limestone. In this arrangement there are enumerated several genera of Polyparia, including *Spongia?*, *Stylina*, *Caryophyllia*, *Turbinolia*, &c.; several species of Crinoidea, and genera of Conchifera and Mollusca.

After a detailed description of many species in each of the above classes, the author concludes, that as the number of Zoophytes bears a very large proportion to that of the Bivalves and Univalves, the Plymouth limestone must be considered to be one of the earliest deposits. But he states that great obscurity still involves the relative distribution of these animals in their order of superposition.

A paper was afterwards read, "On the gradual Excavation of the Valleys in which the Meuse, the Moselle, and some other Rivers flow;" by G. Poulett Scrope, Esq., F.G.S. F.R.S.

The paper commences by a remark on the value which would attach to a test by which any one valley could be ascertained to be the result either of a rapid and violent, or of a slow and gradual excavatory process; since the forces of aqueous erosion are of a general nature, and while in activity in one river channel, were probably not idle in others. Such a test has been pointed out by the author in central France, where lava-currents which have flowed into valleys at intervals of time, appear now at different heights above the actual river-bed, marking the successive steps of the progress of excavation.

The author finds another equally valuable test in the extreme sinuosities of some valleys. Any sudden, violent, and transient rush of water of a diluvial character, could only produce straight trough-shaped channels in the direction of the current, but could never wear out a series of tortuous flexures, through which some rivers now twist about, and often flow for a time in an exactly opposite direction to the general straight line of descent, which a deluge or debacle would naturally have taken. Curvatures of this extreme kind are frequent in the channels of rivers flowing lazily through flat alluvial plains; and the author shows the mode in which the curves are gradually deepened and extended, till the extreme of aberration is corrected at once, and the direct line of descent restored, by the river cutting through the isthmus, which separates two neighbouring curves.

But examples must be infinitely rarer of whole valleys characterized by extreme sinuosity; because, in the author's opinion, the frequent shiftings of the channels of streams tend to obliterate their windings, and reduce the sum of the several successive excavations or valley to a more or less straight form. Still there are occasional instances where the bias of the river, or direction of its lateral force of excavation, has remained so constant as to give to the valley itself the utmost degree of sinuosity.

The author quotes the valley of the Moselle between Berncastle and Roarn, excavated to a depth of from 600 to 800 feet through



an elevated platform of transition rocks. The windings are often so extreme, that the river returns after a course of seventeen miles in one instance, and nearly as much in two others, to within a distance of a few hundred yards of the spot it passed before; wearing away on either side the base of the ridge-shaped isthmus that separates the curves, and inclosing a peninsula of elevated land five or six hundred feet high; but sloping *towards* the bottom of the curves, where it is strewn with boulders, left there, the author presumes, by the river as it gradually deepened its channel and extended its lateral curvature.

The valley of the Meuse near Givet, offers, through a great distance, a number of similar windings, and the same thing is seen at intervals in many of the other rivers of that country. Parts of the Seine below Paris, and the valley of the Wye between Hereford and Chepstow, are examples nearer home.

Valleys which like these twist about in the same regular curves as the channel of a brook meandering through a meadow, can, according to the author, only be accounted for by the slow and long-continued erosion of the streams that still flow in them, increased at intervals by wintry floods. To attribute them to a transient and tremendous rush of water in the main direction of the valley, is in his opinion impossible. He contends that whilst these valleys were slowly excavated, other rivers could not have been idle during the same protracted period; but will have produced likewise an amount of excavation proportioned to their volume and velocity, and the nature of the rocks they flowed over. In the examples quoted, the rocks are mostly hard transition strata, yet the valleys are wide and deep. Where softer strata, as sands, clays, and marls, were the materials worked upon, the valleys excavated may be expected, as they are found to be, far wider in proportion to the volume of water flowing through them. The comparative softness of the materials also, by accelerating the lateral erosion of the stream, will have multiplied the shiftings of its channel, and reduced their sum with greater certainty to one average direction. Hence the deeply sinuous valleys are only found penetrating the more solid rock formations. The author thinks that a certain subdued velocity in the stream is also necessary to produce this result; and, therefore, in mountainous districts, where the torrents and rivers are most rapid, their course is nearly straight; thus confirming the author's opinion, that extreme curvature of channel can only be produced by a slow and comparatively tranquil process of excavation.



PROCEEDINGS  
OF  
THE GEOLOGICAL SOCIETY OF LONDON.

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1830.

No. 15.

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AT THE  
*ANNUAL GENERAL MEETING,*

*19th February 1830.*

A Report from the Council was read, of which the following is an abstract :—

The experience of a year enables the Council to state with confidence, that the late change of apartments has been attended with most beneficial results, both in the increased facilities of exposing to view the collections of the Society, and in affording more ample, though yet scarcely sufficient, accommodation to the rapidly increasing number of Fellows.

The Council beg to call the attention of the Society to the following statement, which points out many deficiencies in the collection ; and they trust that all the Fellows will interest themselves warmly in contributing such specimens of organic remains, as will fill up the numerous blanks which still exist in the English series.

Report upon the Museums and Library.

I. ENGLISH COLLECTION. The whole of this collection, the arrangement of which had been commenced and considerably advanced by the labours of Mr. Greenough, has been placed by the Curator, Mr. Lonsdale, in the order of superposition, in conformity with the directions of the Council ; and the arrangement of about one third of it may be considered complete ; duplicates having been rejected, and the organic remains having been labelled and fixed upon descriptive tablets, so as to obviate the necessity of a perpetual reference to a special catalogue in each drawer. The Curator has at the same time made some progress in a general catalogue, which when completed will be laid upon the table of the Museum. On examining the drawers in a descending order, the Committee beg to submit the following observations to the Council.

*Alluvium.* Of this part of the collection there is only one drawer, containing no specimens of any interest. It may, therefore, be considered as very deficient.

*Diluvium.* All superficial transported materials not connected with the existing drainage of the country, are arranged in this division. The vertebrated animals, as in all other parts of the series, have been classed according to the system of Cuvier, and the invertebrated according to that of Lamarck; and many of the specimens have been specifically determined by the Curator.

*Cavern Remains.* There is a good series from Kent's-hole; but the collection from Kirkdale is defective; and from Banwell and other localities there is not a single specimen.

*Bovey Coal.* This deposit is badly illustrated.

*Crag.* Of the organic remains there are many fine specimens; but the collection is defective in the rock itself, and several species of corals and shells are wanting.

*Fresh Water Formations.* These are tolerably complete; and the inferior tertiary formations are equally well illustrated.

*Chalk.* A good series, but many species of the organic remains are wanting.

*Green Sand Series.* It is comparatively perfect; but it requires many additional fossils, particularly from the lower green sand.

*Weald and Hastings Formations.* Of these deposits there are some good specimens; but on the whole the suite is incomplete.

*Purbeck and Portland Beds.* There is a want of organic remains, especially of the silicified woods and vegetables.

*Kimmeridge Clay.* Specimens of the coal and even of the characteristic fossils are very deficient.

*Coral Rag Series.* The calcareous grit of this division is poor in organic remains.

*Oxford Clay.* There are only a few imperfect specimens of rocks and fossils; this portion of the oolitic series being worse illustrated than any other in the Museum.

*Lower Oolitic System.* Of the succeeding members of the oolitic series and the lias, the most deficient in fossils are the great and inferior oolites: in other respects this series is rich.

We must here, however, remark, that there is yet an almost entire want of the plants and fossils of the oolite coal-field of Yorkshire.

*New Red Sandstone and Magnesian Limestone.* There is a fine collection of rock specimens; but the rarer organic remains, such as the fishes of the marl-slate, are wanting.

*Coal Measures.* The suite from the north of England is rich, whilst that from the south-western coal-field is singularly poor. The former owes a considerable portion of its value to the recent donations of fossil plants by Mr. Hutton.

*Mountain Limestone.* The rock specimens are numerous, but the organic remains are few in number.

The Curator has not advanced further with his arrangement of the inferior formations, and therefore the Committee cannot report upon the value of the suites of transition and primal rocks, of which there is, however, a very large number.

II. **THE SCOTCH COLLECTION** was arranged last year by a Committee, in the order of superposition, and remains in the same state in which they left it. The collection comprises a very fine series of all the formations of that country hitherto described.

III. **THE IRISH COLLECTION** has never been placed in stratigraphical order, but is distributed by counties. As a general collection it is defective, although some counties are well illustrated.

IV. **THE FOREIGN COLLECTION**, which is valuable, and has been considerably increased of late years, has been put into a preliminary geographical order.

V. **SIMPLE MINERALS.** The Curator has bestowed much labour in completing the classification of this division of the Museum, according to the system given in the last edition of Phillips's *Mineralogy*.

VI. **RECENT SHELLS.** The valuable cabinet bequeathed by Capt. Apsley, together with many other recent shells, formerly possessed by the Society, having been partly arranged by Mr. Broderip, has been since classed and named by the Curator, according to the system of Lamarck, and can therefore now be consulted with advantage.

VII. **LIBRARY.** A new arrangement of the books has been made, and a rough catalogue compiled, of which a perfect copy is in progress. There is a very great deficiency in many works of reference, which it would be important for the Curator and all students in the Museum to consult; and among these the Committee wish particularly to point out

Adolphe Brongniart. *Végétaux Fossiles.*

Lamouroux. *Exposition Méthodique.*

Goldfuss. *Petrefacta.*

In conclusion, the Committee beg leave to express their entire satisfaction with the great progress which the Curator has already made, and the talent which he has displayed in the arrangement of the various collections of the Society; and they feel convinced that nothing short of an entire devotion of his time and abilities to the objects of the Society, could have enabled him to accomplish so much in so short a period.

The Wollaston Fund has been increased by the sum of £84 1s. 1d. stock, being the remaining part of a subscription entered into some years ago to defray the expenses attending certain geological inquiries in Great Britain and Ireland.

The Council have not thought it expedient to make, as yet, any distribution of the dividends arising from this fund, but have appropriated the first year's income to the acquisition of a die for a medal, which is to bear on it the head of Dr. Wollaston; and they hope that the Society will approve of this endeavour to perpetuate in the minds of Geologists the memory of their illustrious benefactor. The first annual distribution, therefore, of the Wollaston Medal, as well as of a certain sum of money, will be awarded at the next Anniversary according to the provision of the bequest.

Comparative Statement of the number of the Society, at the close of the years 1828—1829.

Fellows.	31st Dec. 1828.	31st Dec. 1829.
Having compounded .....	48.....	56
Contributing .....	147.....	164
Non-residents .....	224.....	243
	<hr/>	<hr/>
	419	463
Honorary Members .....	51.....	51
Foreign Members .....	52.....	55
Personages of Royal Blood .....	2.....	3
	<hr/>	<hr/>
Total	524.....	572

*The following Persons were elected Fellows and Foreign Members between the last Anniversary and the close of the year 1829.*

- March 6th.—S. P. Pratt, Esq. of Lansdown Place West, Bath; and the Rev. Robert Everest, M.A. of Devereux Court, Temple.
- March 20th.—Robert Wm. Blencowe, Esq. M.A. of Gloucester Place; Robert Otway Cave, Esq. M.P. of Upper Grosvenor Street; Samuel Edward Cooke, Esq. Capt. R.N. of Newton, Northumberland; Robert Daubeny, Esq. of Burlington Gardens, Cork Street; George Lowe, Esq. of Highgate; and Peter Fearon, Esq. of the Temple.
- April 3rd.—Samuel Upton, Esq. M.A. of Trinity College, Cambridge; Edward Wynn Pendarves, Esq. M.P. of Pendarves, Cornwall, and Grosvenor Street; the Rev. John Lodge, M.A. Fellow of Magdalen College, and Principal Librarian of the University of Cambridge; the Rev. John Brown, M.A. Fellow of Trinity College, Cambridge; Sir John Franklin, Capt. R.N. of Devonshire Street, Portland Place; and William A. Cadell, Esq. of Edinburgh.
- May 1st.—Samuel Cartwright, Esq. of Old Burlington Street; and John Hall, Esq. of Edinburgh.
- May 15th.—William Babington, Esq. of St. John's Wood, Regent's Park; and Henry Humphrey Goodhall, Esq. of the East India House.
- June 5th.—William Lonsdale, Esq. of Somerset House; the Rev. Thos. Thorpe, M.A. Fellow of Trinity College, Cambridge; the Right Rev. John Matthias Turner, D.D. Lord Bishop of Calcutta; David Douglas, Esq. of Turnham Green; Thomas Erskine Perry, Esq. of Trinity College, Cambridge; and Thomas Earle, Esq. of Park Square, Regent's Park.
- June 19th.—James Morrison, Esq. Portland Place; and Daniel Sharpe, Esq. of New Ormond Street.
- Nov. 6th.—George Biddell Airy, Esq. Trinity College, Cambridge, and Professor of Astronomy in that University; John Macpherson Grant, Esq. of Ballindalloch, N.B.; John Heywood Hawkins, Esq. of Bignor Park, Sussex; Philip Duncan, Esq. Fellow of New College, Oxford; and William Cavendish, Esq. M.P. of Belgrave Square.
- Nov. 20th.—James Robert Gowen, Esq. of Highclere, near Newbury; and William Holbech, Esq. of Farnborough, Warwickshire.

Dec. 4th.—Nicholas Dennys, Esq. of Cambridge Terrace, Regent's Park; John Willimott, Esq. of Jermyn Street, St. James's; William Higgins, Esq. of Coggeshall, Essex; and Edward Spencer, Esq. of Highgate.

Dec. 16th.—Benjamin Blake, Esq. Captain of the Bengal Army; Matthias Atwood, Esq. M.P. of Gracechurch Street, and Muswell Hill, Middlesex; James Hall, Esq. of Southampton Row, London.

*Foreign Members.*

Dec. 4th.—His Imperial Highness, John, Archduke of Austria; Professor Hausmann of Göttingen; Professor Hoffmann of Berlin; Professor Voltz of Strasbourg; M. Dufrénoy of Paris; and Dr. Boué.

Dec. 16th.—M. D'Omalius D'Halloy, Governor of the Province of Namur in the Kingdom of the Netherlands.

The Names of the Fellows deceased, within the past year, are as follow:—

Compounders	.....	(None.)
Residents	.....	{ Thomas William Carr, Esq. John Fleming, M.D.
Non-resident.	.....	
	.....	Rev. J. Holme.
Foreign	{	M. Sebastian Leman.
		Le Chevalier Nix Louis Vauquelin.
		Senor Juan Antonio de Monteiro.
Honorary	.....	(None.)
Omitted among the Non-residents of 1828, Joseph Carne, Esq.		

The MUSEUM has received many donations since the last Anniversary, of which the following are the more valuable:—

*British and Irish Specimens.*

- Wavellite from Cork; presented by Thomas Meade, Esq. F.G.S.  
Specimens illustrative of the neighbourhood of Devizes, Wiltshire; presented by J. C. Anstie, Esq. F.G.S.  
A Slate containing Coprolites from the Lias; and a cast of a toe of the Iguanodon, found in Sandown Bay, Isle of Wight; presented by the Rev. Wm. Buckland, D.D. V.P.G.S. F.R.S.  
A collection of Fossil Plants from the Northumberland and Durham Coal-field; presented by William Hutton, Esq. F.G.S.  
A series of specimens from a well sunk near Northolt, in the London and Plastic Clays; presented by the Rev. J. H. Randolph, F.G.S.  
Specimens of artificial Oxide of Tin, of Tungstate of Lime, and a Mineral from Cornwall; presented by T. Mitchell, Esq. through Davies Gilbert, Esq. Pres. R.S. F.G.S.

- Two specimens of Sulphate of Strontian on Lias, from Cotham near Bristol ; presented by J. S. Miller, Esq.
- A very fine specimen of Pentacrinites Briareus ; one fine portion and four others of the Tusks of the Mammoth, a Dapedium politum, and other Fossils from Lyme Regis ; presented by H. T. De la Beche, Esq. F.G.S. F.R.S.
- A specimen of Galena from Alston Moor in Cumberland ; presented by the Rev. William Branwhite Clarke, F.G.S.
- Marsupites from the Chalk at Brighton, and a cast of Hamites gigas with other Fossils from Sandgate ; presented by Henry Humphrey Goodhall, Esq. F.G.S.
- A collection of Fossil fishes from Banffshire ; presented by Rod. Impey Murchison, Esq. Sec. G.S. F.R.S.
- A fine specimen of Cycadeoidea, a polished Septarium, and several fossil and recent shells, from Weymouth ; presented by Miss Benett.
- Jaw-bone of a Horse ; jaw-bone of a Stag, and other bones found in digging the foundation of Staines Bridge ; presented by A. B. Lambert, Esq. F.G.S. V.P.L.S.
- Specimens from the Suffolk Crag ; presented by Richard Cowling Taylor, Esq. F.G.S.

*Foreign Specimens.*

- A cast of the Head of the Mosasaurus from Maestricht ; presented by Baron G. Cuvier, For. Mem. G.S.
- Specimens of tertiary and secondary rocks, with their accompanying Fossils, from the neighbourhood of Bassano ; and a collection of Fossil fishes from Seefeld in the Tyrol ; presented by Roderick Impey Murchison, Esq. Sec. G.S. F.R.S.
- Specimens of the Freshwater and Volcanic Formations of the Cantal in France ; presented by Charles Lyell, Esq. For. Sec. G.S. F.R.S. and Rod. Impey Murchison, Esq. Sec. G.S. F.R.S.
- Rocks from Chamonix and its environs ; presented by J. Auldjo, Esq. F.G.S.
- Rocks and organic remains from the Vosges, and the neighbourhood of Strasbourg ; presented by Professor Voltz, For. Mem. G.S.
- Fossil wood from the Rio Nigro ; presented by George Loddiges, Esq.
- Volcanic productions from New South Wales : presented by the Right Hon. Lord F. Leveson Gower, F.G.S.
- A specimen of Meteoric iron from Atacama in Peru ; presented by Woodbine Parish, Esq. His Majesty's Chargé d'Affaires, and Consul General at Buenos Ayres.
- Two collections of Fossil shells from Sicily ; presented by the Marquis of Northampton, F.G.S.
- Rock specimens from Egypt ; presented by Lord Prudhoe.
- A collection of specimens from the country between Calcutta and Cuttack ; presented by the Asiatic Society of Calcutta.
- Two series of specimens, one to illustrate the neighbourhood of Nice, and the other the shores of the Gulf of La Spezia ; presented by H. T. De la Beche, Esq. F.G.S. F.R.S.



- A collection of Fossils from the Atlantic Frontier of the United States ; presented by Dr. Morton.
- Cast of the *Pterodactylus longirostris* from Eichstadt, and a cast of some of the bones of a *Pterodactylus* from the same place ; presented by Professor Soemmering.
- A collection of bones of the *Ursus spelæus*, from the Cave of Gailenreuth in Franconia ; presented by Viscount Cole, F.G.S. and Sir Philip de Malpas Grey Egerton, Bart. F.G.S.
- A collection of specimens from the Mining District of Guanaxuato ; presented by J. Dickson, Esq.
- Crystals of Muriate of Soda on Lava from Vesuvius ; presented by Mrs. Somerville.

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The LIBRARY has been increased by the donation of 85 volumes and pamphlets.

The Supplement to the Second Volume, and the First Part of the Third Volume of the Society's Transactions, have been published since the last Anniversary.

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*List of PAPERS read since the last Annual Meeting, Feb. 20, 1829.*

- March 6.—An account of a remarkable Fossil Plant in the Coal Formation of Yorkshire ; by John Lindley, Esq. F.G.S. F.R.S. Professor of Botany in the University of London.
- On the Remains of Quadrupeds which have been discovered in the Marine and Fresh-water Formations of the Peninsula of Italy ; (Part First) by J. B. Pentland, Esq.
- March 20.—On the Tertiary and Secondary Rocks forming the Southern Flank of the Tyrolese Alps, near Bassano ; by Roderick Impey Murchison, Esq. Sec. G.S. F.R.S.
- April 3.—A Letter from Dr. Prout to Professor Buckland on the Analysis of Coprolites from Lyme Regis and Westbury-on-Severn.
- On the Bituminous Schist and Fossil Fishes of Seefeld in the Tyrol ; by Roderick Impey Murchison, Esq. Sec. G.S. F.R.S.
- April 3, and May 1.—On the Tertiary Deposits of the Cantal, and their relations to the Primary and Volcanic Rocks ; by Charles Lyell, Esq. For. Sec. G.S. F.R.S., and Roderick Impey Murchison, Esq. Sec. G.S. F.R.S.
- May 15, and June 5.—On the Hydrographical Basin of the Thames, with a view more especially to investigate the causes which have operated in the formation of the valleys of that river and its tributary streams ; by the Rev. Wm. Conybeare, F.G.S. F.R.S. Instit. Reg. Soc. Paris. Corresp.
- June 5.—A few facts and observations on the power which running water exerts in removing heavy bodies ; by Matthew Culley, Esq. F.G.S., in a letter to Roderick Impey Murchison, Esq. Sec. G.S. F.R.S. &c.
- June 19.—On the occurrence of Agates in the Dolomitic strata of the new red sandstone formation in the Mendip Hills ; by the Rev. Wm. Buckland, D.D. V.P.G.S. F.R.S.

- June 19.—On the Tertiary Freshwater Formation of Aix in Provence, including the Coal-field of Fuveau ; by Roderick Impey Murchison, Esq. Sec. G.S. F.R.S., and Charles Lyell, Esq. For. Sec. G.S.
- Nov. 6.—On the Tertiary Deposits of the Valley of Gosau in the Salzburg Alps ; by the Rev. Adam Sedgwick, Pres. G.S. F.R.S., and Roderick Impey Murchison, Esq. Sec. G.S. F.R.S.
- Nov. 20, and Dec. 4.—On the Tertiary Formations which range along the flanks of the Salzburg and Bavarian Alps, being in continuation of the Memoir on the Valley of Gosau ; by the Rev. Adam Sedgwick, Pres. G.S. F.R.S., and Roderick Impey Murchison, Esq. Sec. G.S. F.R.S.
- Dec. 4.—On the discovery of bones of the Iguanodon and other large Reptiles in the Isle of Wight and Isle of Purbeck ; by the Rev. Wm. Buckland, D.D. V.P.G.S. F.R.S.
- Dec. 18.—Observations on part of the Low Countries and the North of France, principally near Maestricht and Aix-la-Chapelle ; by Wm. Fitton, M.D. F.G.S. F.R.S.
- Jan. 1, 1830.—On the Geology of the shores of the Gulf of La Spezia ; by H. T. De la Beche, Esq. F.G.S. F.R.S.
- Jan. 15.—On the Fossil Fox of Cœningen, with a description of the lacustrine deposit in which it was found ; by Roderick Impey Murchison, Esq. Sec. G.S. F.R.S.
- Feb. 5.—A Catalogue raisonné of Fossils from the Transition Limestone of Plymouth ; by the Rev. Richard Hennah, F.G.S.
- On the Formation of the Valleys in which the Meuse, the Moselle, and some other rivers flow ; by Poulett Scrope, Esq. F.G.S. F.R.S.

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The following LIST contains the NAMES of all the Persons, from whom Donations to the Library and Museum have been received, during the past year.

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|-----------------------------------|----------------------------------|
| Anstie, J. O. Esq. F.G.S.         | Broderip, W. J. Esq. Sec. G.S.   |
| Asiatic Society of Calcutta.      | F.R.S. F.L.S.                    |
| Astronomical Society of London.   | Brongniart, M. Adolphe.          |
| Auldjo, John, Esq. F.G.S.         | Brongniart, M. Alexandre, For.   |
|                                   | Mem. G.S.                        |
| Barnard, — Esq.                   | Brookes, Joshua, Esq.            |
| Beaumont, Elie de, For. Mem.      | Buch, M. Leopold de, For. Mem.   |
| G.S.                              | G.S.                             |
| Benett, Miss.                     | Buckland, Rev. William, D.D.     |
| Berlin Royal Academy of Sciences. | V.P.G.S. F.R.S. &c.              |
| Bertrand De Doue, Mons. J. M.     | Cambridge Philosophical Society. |
| For. Mem. G.S.                    | Clarke, James, M.D.              |
| Bostock, John, Esq. M.D. F.R.S.   | Clark, Rev. W. Branwhite,        |
| F.G.S.                            | F.G.S.                           |
| Bouillet, M. Jacq. B. Mem. de     | Cole, Right Honourable Viscount. |
| la Société pour l'Industrie Nat.  | F.G.S.                           |
| Bristol Institution.              | Cuvier, Baron, For. Mem. G.S.    |

De la Beche, H. T. Esq. F.G.S.  
F.R.S. F.L.S.

Dechen, Henrich Von, For. Mem.  
G.S.

Desnoyers, M. Jules.

Dickson, J. Esq.

Editors of the Edinburgh Journal  
of Natural and Geographical  
Science.

Egerton, Sir Philip de Malpas  
Grey, Bart. F.G.S.

Everest, Rev. Robert, F.G.S.

Gilbert, Davies, Esq. Pres. R.S.  
F.G.S.

Goodhall, Henry Humphrey, Esq.  
F.G.S.

Gower, Right Hon. Lord Francis  
Leyeson, M.P. F.G.S.

Hausmann, Professor, For. Mem.  
G.S.

Horticultural Society of London.  
Hullmandel, Mr.

Hutton, William, Esq. F.G.S.

Klipstein, Mons. A.

Lacordaire, Mons.

Lambert, A. B. Esq. F.R.S.  
V.P.L.S. F.G.S. &c.

Larivière, M. Engelsbach.

Leonhard, M. Carl Von, For. Mem.  
G.S.

Loddiges, George, Esq.

Loudon, J. C. Esq. F.G.S. F.L.S.

Lyell, Charles, Esq. For. Sec.  
G.S. F.R.S. F.L.S.

Martin, P. J. Esq.

Meade, Thomas, Esq. F.G.S.

Miller, J. S. Esq. A.L.S.

Morton, S. G. M.D.

Moulins, M. Charles, des.

Murchison, R. Impey, Esq. Sec.  
G.S. F.R.S. F.L.S.

Necker, M. Louis Albert, For.  
Mem. G.S.

Northampton, Most Hon. Marq.  
of, F.G.S.

Oeynhausien, M. Karl Von, For.  
Mem. G.S.

Oriental Translation Fund Com-  
mittee.

Parish, Woodbine, Esq. His Ma-  
jesty's Chargé d'Affaires, and  
Consul General at Buenos  
Ayres.

Phillips, Richard, Esq. F.G.S.  
F.R.S. F.L.S.

Phillips, John, Esq. F.G.S.

Pierola, Señor N. de.

Prevost, M. Constant, For. Mem.  
G.S.

Randolph, Rev. J. Honeywood,  
F.G.S.

Raspail, Mons.

Rivero, Mons. de.

Royal Academy of Sciences,  
Paris.

Royal Asiatic Society of London.

Royal Institution of Great Bri-  
tain.

Royal Irish Academy.

Royal Society of London.

Serres, M. Marcel de, Prof. Min.  
et Geol. à la Faculté des Sci-  
ences de Montpellier.

Silliman, Professor, M.D. For.  
Mem. G.S.

Society of Arts.

Soemmering, Professor.

Somerville, Mrs.

South, J. Esq. F.R.S. V.P.A.S.

Taylor, Richard, Esq. F.G.S.  
F.L.S.

Taylor, Richard Cowling, Esq.  
F.G.S.

Voltz, Professor, For. Mem. G.S.

Yates, Rev. James, M.A. F.G.S.

Yorkshire Philosophical Society.

Young, Rev. George, M.A.

*Sums actually Received and Expended,*

## RECEIPTS.

Balances in hand Jan. 1, 1829 :	£.	s.	d.	£.	s.	d.
Banker .....	607	4	9			
Clerk .....	26	12	0			
Collector .....	31	10	0			
	<hr/>			665	6	9

Arrears :	£.	s.	d.
of Admission Fees . . . . .	60	18	0
of Annual Contributions . . . . .	22	0	0
of Subscriptions towards the Outfit } of Somerset House . . . . . }	32	6	6
	<hr/> 115 4 6		

To Credit of General Fund from Repairing Fund.... 133 6 9

Ordinary Income:	£.	s.	d.
Annual Contributions .....	406	17	6
Admission Fees :	£.	s.	d.
Residents .....	132	6	0
Non-Residents .....	157	10	0
	<hr/>	289	16 0
	<hr/>	<hr/>	696 13 6

Compositions, eight .....	248	17	0
Transactions sold .....	160	12	0
Proceedings sold .....	1	18	0

Wollaston Fund ..... 27 17 0

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£2049 15 6

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during the year ending 31st December 1829.

## PAYMENTS.

£. s. d.

Outfit of Apartments in Somerset House, chargeable } upon General Fund.....	683	4	1½
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## General Expenditure :

£. s. d. £. s. d.

House repairs, (1829) .....	11	7	1½
Taxes and Parochial } charges .....	46	7	8
Insurance .....	6	0	0
Furniture .....	63	5	3
House expenses .....	157	2	11½

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 284 3 0

## Salaries and Wages :

£. s. d.

Curator.....	184	12	0
Collector's poundage .....	26	0	0
Porter and Servant .....	85	0	0

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 295 12 0

## Scientific Expenditure :

£. s. d.

Books, Casts, Cases, &c....	127	17	8
Stationery and Miscella- } neous Printing .....	60	6	4

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 188 4 0

## Miscellaneous :

Tea and Waiters for Meet- } ings .....	26	17	10
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## Cost of Publications :

£. s. d.

Transactions.....	95	11	0
Proceedings .....	4	5	0½

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 99 16 0½

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 894 12 10½

Contributions refunded .....	9	9	0
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## Balances in hand ; 31st Dec. 1829.

£. s. d.

Banker .....	419	4	6
Accountant .....	43	5	0

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 462 9 6

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 £2049 15 6
 

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# VALUATION of the Society's Property; 31st December 1829:

PROPERTY.		DEBTS.	
	£. s. d.		£. s. d.
Balances in hand (see last sheet) .....	462 9 6	Bills outstanding:	
Arrears due to the Society:		Transactions, vol. 3, }	476 0 11
Admission Fees .....	111 6 0	pt. 1. ....	
Contributions .....	149 9 0	vol. 2. pt. 3 ....	2 10 0
		Supple..	40 17 9
	260 15 0		519 8 8
Estimated value of unsold Transactions .....	1200 0 0		
		£. s. d.	
		Printing of Proceed- }	37 0 6
		ings.....	
		Miscellaneous Print- }	25 19 6
		ing .....	
			63 0 0
		Sundries .....	79 14 11½
		Salaries and Collector's pound- }	78 19 6
		age .....	
			741 3 1½
		Cash belonging to "Wollaston Fund" .....	57 17 0
		Arrears not likely to be received .....	50 0 0
		Balance in favour of the Society .....	1074 4 4½
			£1923 4 6

[N.B. The value of the Collections, Library, and Furniture is not here included: nor is the amount of the "Donation Fund" instituted by the late Dr. Wollaston; being at present 1084l. 1s. 1d. in the Reduced 3 per cent. Annuities; the dividends thereof being appropriated to the purposes suggested by the Founder.]

We have compared the Books and Vouchers presented to us, with these Statements, and find them correct.

Feb. 4, 1830.

Signed, J. F. VANDERCOM.  
J. E. BICHENO.

# ESTIMATES for the ensuing year: to 31st December 1830.

## INCOME EXPECTED.

	£.	s.	d.
Arrears due to the Society Dec. 31st 1829. (See last sheet).	260	15	0
Ordinary Income 1830. (estimated.)	£.	s.	d.
Contributions of 155 Fellows	465	0	0
Admission Fees:			
Residents (24)	151	4	0
Non-residents (20)	210	0	0
	826	4	0
Compositions, (four).	126	0	0

## EXPENSES ESTIMATED.

	£.	s.	d.	£.	s.	d.
Debts, outstanding 31st Dec. 1829.						
Printing of Transactions	519	8	8			
Proceedings, &c.	63	0	0			
Taxes	42	16	5			
Sundries	79	14	11½			
Salaries and Collector's poundage.	78	19	6			
				783	19	6½

## General Expenditure 1830 :

	£.	s.	d.
House.			
Repairs.	50	0	0
Taxes	85	0	0
Insurance.	6	0	0
	141	0	0

## Salaries and Wages :

Curator	200	0	0
Collector's poundage	15	0	0
Porter and Servant.	90	0	0
	305	0	0

Coals, Gas, Oil, &c.	60	0	0
Scientific Expenditure	120	0	0
and Stationery.	70	0	0
Miscellaneous	250	0	0
	696	0	0

## Publications :

Proceedings	30	0	0
Transactions			
	30	0	0

Sale of Transactions	250	0	0
Dividends on "Wollaston Donation Fund" (2 years)	57	17	0
Balance against the Society.	97	0	6½
	£1617	16	6½

Arrears not likely to be received	50	0	0
Employment of "Wollaston Donation Fund."	57	17	0
	£1617	16	6½

The Meeting then proceeded to the election of the Officers and Council for the ensuing year; when the following list was delivered in by the Scrutineers :—viz.

## OFFICERS.

### *PRESIDENT.*

Rev. Adam Sedgwick, M.A. F.R.S. Woodwardian Professor in the University of Cambridge.

### *VICE-PRESIDENTS.*

William John Broderip, Esq. B.A. F.R.S. L.S. & H.S.

Davies Gilbert, Esq. M.P. M.A. Pres. R.S. Hon. M.R.S.E. F.S.A. L.S. & H.S.

Leonard Horner, Esq. F.R.S. L. & E. Warden of the Univ. of London.

Henry Warburton, Esq. M.P. M.A. F.R.S. L.S. & H.S.

### *SECRETARIES.*

Roderick Impey Murchison, Esq. F.R.S. & L.S.

Edward Turner, M.D. F.R.S. L. & E. Professor of Chemistry in the University of London.

### *FOREIGN SECRETARY.*

Charles Lyell, Esq. M.A. F.R.S. & L.S.

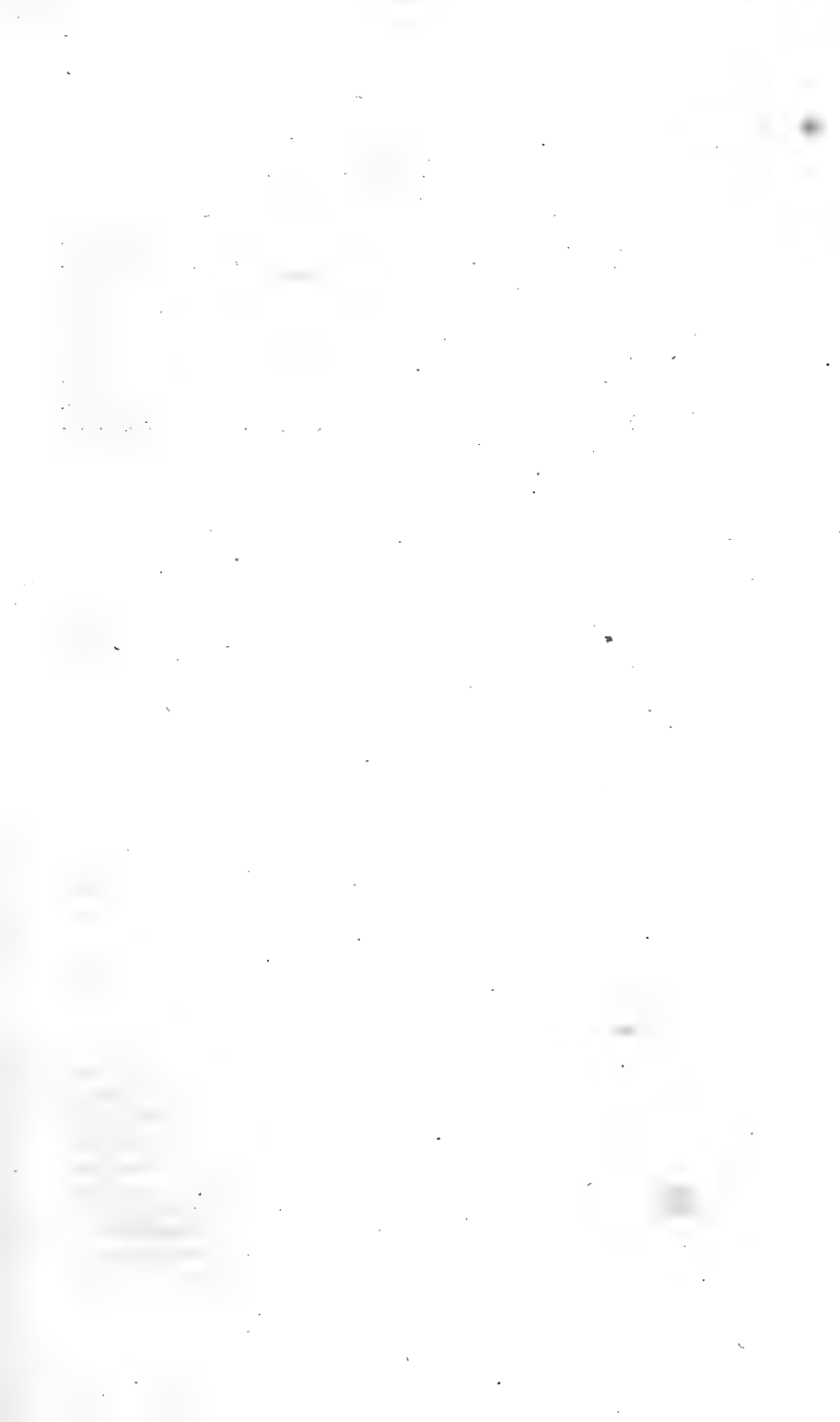
### *TREASURER.*

John Taylor, Esq. F.R.S. & H.S.

## COUNCIL.

Arthur Aikin, Esq. F.L.S. Sec. to the Society of Arts.	John Lindley, Esq. F.R.S. L.S. & H.S. Professor of Botany in the University of London.
Rev. William Buckland, D.D. F.R.S. & L.S. Professor of Mineralogy and Geology in the University of Oxford.	Rev. J. Honywood Randolph, M.A. Peter Mark Roget, M.D. Sec. R.S. F.L.S. M.R.I.A.
Francis Chantrey, Esq. D.C.L. R.A. F.R.S. S.A. & H.S.	Charles Stokes, Esq. F.R.S. S.A. & L.S. M.R.A.S.
Sir Alexander Crichton, K.S.W. M.D. F.R.S. & L.S.	James Vetch, Esq. Capt. R.E. M.W.S.
Henry Thomas Dela Beche, Esq. F.R.S. & L.S.	Nicholas Aylward Vigors, Esq. M.A. Sec. Z.S. F.R.S. S.A. L.S. H.S. & M.R.I.A.
Sir John Franklin, Capt. R.N. D.C.L. F.R.S.	Rev. W. Whewell, M.A. F.R.S. Professor of Mineralogy in the University of Cambridge.
George Bellas Greenough, Esq. F.R.S. L.S. & H.S. M.R.A.S.	





The Report having been read, it was resolved,—

1st. That this Report be received.

2ndly. That the thanks of this Society be given to the Rev. W. Buckland, D.D., and George Bellas Greenough, Esq., retiring from the Office of Vice-Presidents.

3rdly. That the thanks of this Society be given to William John Broderip, Esq., retiring from the Office of Secretary.

4thly. That the thanks of this Society be given to James Ebenezer Bicheno, Esq., John Bostock, M.D., Decimus Burton, Esq., Captain George Everest, Michael Faraday, Esq., William Henry Fitton, M.D., Nathaniel Wallich, M.D. and the Rev. James Yates, retiring from the Council.

At the Meeting of the Society in the evening, the following Address was delivered by the President from the Chair :

GENTLEMEN,

YOU have heard the report of the Council on the general state of our Society, containing an account of its property and of its debts, of the several sums received and expended during the last year, and a careful estimate of all our resources for the current year. You have also heard a separate report, from a select Committee, respecting the various collections of our Museum, and the progress which has been made in their arrangement.

I cannot allow this opportunity to pass away without expressing my hearty concurrence in the sentiments recorded by the Committee, and my admiration of the talents exhibited by our Curator, in a task of no common difficulty and of almost incredible labour. At the same time, I should ill express my own feelings and those of the Society, did I not on this occasion also acknowledge the great obligations we owe to several members of our Council, and especially to Mr. Greenough, who during many years has fully given to us the benefit of his labour and talents, both in directing us to those sources from which our collection might be supplied, and in arranging systematically the various specimens accumulated from time to time in our cabinets.

One result has been obtained from the excellent stratigraphical arrangements of Mr. Lonsdale, which I had not myself anticipated; they not only place in an instructive point of view the excellencies, but also the defects of our collection; and it appears from the report of the Committee, that some of the suites of specimens intended to illustrate the secondary formations of England are eminently defective. It will be the endeavour of the Council by the exchange of duplicates, and by all other means within their reach, to fill up these chasms in the Museum: and in effecting this object they look forward to the friendly cooperation of provincial bodies, associated for purposes like our own, and, above all, to the zeal and generosity of our own Members.

You will perceive, Gentlemen, from the report of the Council, that in the general estimate of the receipts and expenditure of the current year, there is a balance of about ninety pounds against the Society. Even such a deficit as this would produce feelings of deep regret, were it an indication of any general falling off in our resources; but the fact admits of ready explanation without any such disheartening conclusion. Our annual income is decidedly on the increase; but our general funds have not yet entirely recovered from the drain upon them which took place when we came into the occupation of these apartments. And during this year, besides paying up heavy arrears, we have incurred an expense of more than six hundred pounds in the publication of our Memoirs. There is, however, now laid up in the cabinets of the Museum a literary stock amounting in value to not less than twelve hundred pounds; which, though but in a small degree available against the present

claims upon the Society, must in the end be productive of a considerable return.

Of the merits of the several memoirs in our last publication I am not called upon to speak ; but I may direct the attention of the Gentlemen present to the number and beauty of its embellishments : and I am happy to record the expression of my thanks to Mr. Broderip, for the care with which he has superintended every part of it during its passage through the press. That Gentleman now retires from the laborious duties of the office of Secretary, which, for four years, he has filled so greatly to our advantage : but I am well assured, that we may still look with confidence for a not less efficient, though perhaps less laborious, application of his talents and experience in the promotion of our best interests.

During the past year about fifty additional Fellows have been enrolled on the lists of the Society ; and among them I rejoice to observe the names of some persons eminently distinguished in this country by their knowledge in the exact sciences ; and of others to whom we shall hereafter look, not merely for general support, but for active cooperation in the field. We have also added seven to the number of our Foreign Members : and I need not tell the Gentlemen present, that our body is honoured by the addition of these persons to its list\* : for they stand without exception in the foremost rank of those who, by a combination of great labour and great talents, have pushed beyond their former limits those branches of natural knowledge, for the advancement of which we are incorporated. At the head of this number I rejoice to see the name of an illustrious Personage who, amid the distracting duties attached to his exalted rank and commanding station, has found time for the successful cultivation of science, which he adorns by his high intellectual attainments, and urges on by the force of his example.

After placing before you these subjects of congratulation, it is my painful duty to record the loss of an old Member of this Society, who took a deep interest in its wellbeing and progress. By the death of Mr. Holme we have lost a man of rare simplicity of manners, who in a life of retirement pursued science for its own sake, without any alloy of selfish feeling, or any view to his emolument or fame. He was an admirable botanist ; and after many years of application had acquired no ordinary skill in some difficult parts of mineral analysis. In one of the Papers in our last publication I have had repeated occasions of acknowledging my obligations to him.

France has lately been deprived, by the death of M. Vauquelin, of a man who for more than half a century devoted the efforts of

\* His Imperial Highness John Archduke of Austria ; Dr. Ami Boué ; Prof. Hausmann of Göttingen ; Prof. Hoffmann of Berlin ; Prof. Voltz of Strasbourg ; M. Dufrénoy, Professor at the Ecole des Mines, Paris ; and M. D'Omalius D'Halloy, Governor of the Province of Namur in the Kingdom of the Netherlands.

his powerful mind to the promotion of physical truth ; and we have to lament the loss of a name which has long decorated the list of our Foreign Members. A proper homage has been already paid, by the President of the Royal Society, to the memory of this illustrious person; whose labours, however great the light they shed on our department of natural history, were still more nearly connected with exact science.

Several of the Papers read at our meetings, between the last Anniversary and our separation for the summer, have through different channels already come before the public. It would have been well, that at least a part of them should have appeared in our Transactions. But our funds have not always admitted of a sufficiently rapid publication to meet the wishes of those authors who have most original matter to communicate. This is a subject of regret, and well deserves the consideration of the Council for the coming year. The Transactions of the Society form unquestionably the most honourable official record of our labours. It is through them that we are represented in the great republic of science; and without them, beyond our own immediate circle, we possess neither voice nor animation.

The progress of our body in geological inquiry since the former Anniversary, will be best understood by glancing over the various memoirs which have been the subject of discussion at our meetings. It will be useless to do this in the exact order in which they came before us; I shall therefore follow that order in which the subjects themselves appear to be naturally connected with each other.

Our attention has been several times called to the theory of the excavation of valleys, and to the effects produced by river currents in modifying the form of the solid parts of the earth. The subject was introduced during the former year by a memoir of Messrs. Lyell and Murchison, on certain portions of the volcanic regions of Central France; in which they show (in accordance with the views of Montlosier, Scrope, and some other authors) that the existing rivers have, by a long continued erosion, eaten out deep gorges, not only through currents of basaltic lava which have flowed through the existing valleys, but also through solid rocks of subjacent gneiss. They further prove, on evidence which to me seems not short of demonstration, that no great denuding wave or mass of water lifted by supernatural force above its ordinary level, could have assisted in forming such denudations: for the country is still studded with domes of incoherent matter, the remnants of former craters; from which may be traced, continuously, streams of lava, intersected in the courses of the rivers by these deep gorges—the gages and tests of the erosive power of running water during times comparatively recent.

The elaborate Paper of Mr. Conybeare on the valley of the Thames is still fresh in our recollection. He proves that the erosive power of the river has, within the records of history, produced no effect on the general features of the country through which it

flows, and that the propelling force of its waters is not now, and never could have been, adequate to the transport of the boulders which lie scattered on the sides and summits of the chains of hills through which it has found a passage: that much of the waterworn gravel, drifted through the breaches opened in the sinuous line of its channel, is composed of rocks not found within the limits of its basin; and that the form of the country is often the very reverse of that which would have been produced by mere fluvatile erosion, however long continued. Similar facts are supplied by nearly all the greater valleys of England; and on the whole they point to one conclusion, that fluvatile erosion, as a mere solitary agent, has produced but small effects in modifying the prominent features of our island: at the same time they leave untouched all the facts of an opposite kind, supported by direct evidence, whether derived from the volcanic districts of Central France, or from any other physical region on the surface of the earth.

The power of mountain torrents in transporting heavy masses of stone is strikingly illustrated in a short paper by Mr. Culley. He states that a small rivulet, descending from the Cheviot Hills along a moderate declivity, carried down, during a single flood, many thousand tons of gravel into the plains below; and that several blocks, from one-half to three-quarters of a ton weight each, were propelled two miles in the direction of the stream. Facts, similar in kind, but on a scale incomparably greater, must be in the recollection of every one who has seen the Alpine torrents descending into the plains of the north of Italy.

When mountain chains abut in the sea, the laws of degradation are not suspended. At each successive flood, fragments of rock are drifted in the direction of the descending torrents, and rolled beneath the waters. This kind of action is indeed casual and interrupted; but it is aided by another action which is liable to no intermission—the beating of the surf and the grinding of the tidal currents on all the projecting parts of a steep and rocky shore. Under such conditions, I doubt not that there are now forming at the bottom of the sea, and at depths perhaps inaccessible, alternating masses of silt, and sand, and gravel, which, if ever lifted above the waters, may rival in magnitude some of the conglomerates of our older formations.

Our last Paper, on the excavating power of rivers, was from the pen of Mr. Scrope. He contends that diluvial torrents would only form trough-shaped channels prolonged in the direction of the principal rush of water; but would never produce curves in which the excavating force worked in a direction opposed to that of the general current. He describes part of the course of the Moselle and of the Meuse, where the rivers wind through hard transition rocks, in long sinuous channels, varying in depth from 500 to 1000 feet. In one of the great flexures of the Moselle, the river, after passing over no less than 17 miles, returns to within 500 yards of the point from which it started. These phenomena are regarded by the Author as sure indications of slow fluvatile erosion. For he

considers the idea of a great debacle, or diluvial current, winding its way back in lazy flexures towards the point from which it started, as absolutely unintelligible.

If I might give my own opinion on this debated question, I should say, that the existing river drainage of every physical region, is a complex result, depending upon many conditions—the time when the region first became dry land—its external form at the time of its first elevation above the sea—and all the successive disturbing forces which have since acted upon its surface. But none of these elements are constant: no wonder, then, that results derived from distant parts of the earth should be so greatly in conflict with each other. In the formation of valleys there is therefore little wisdom in attributing every thing to the action of one modifying cause. We know by direct geological evidence, that nearly all the solid portions of the earth were once under the sea, and were lifted to their present elevation, not at one time, but during many distinct periods. We know that elevating forces have not only acted in different places at different times, but with such variations of intensity, that the same formation is in one country horizontal, in another vertical; in one country occupies the plains, in another is found only at the tops of the highest mountains. Now every great irregular elevation of the land (independently of all other results) must have produced, not merely a rush of the retreating waters of the sea, but a destruction of equilibrium among the waters of inland drainage. Effects like these must have been followed by changes in the channels of rivers, by the bursting of lakes, by great debacles, and in short by all the great phenomena of denudation. In comparing distant parts of the earth, we may therefore affirm that the periods of denudation do not belong to one, but to many successive epochs; and by parity of reasoning we may conclude that the great masses of incoherent matter which lie scattered over so many parts of the surface of the earth, belong also to successive epochs, and partake of the same complexity of formation.

The excavation of valleys seems therefore to be a complex result, depending upon all the forces, which, acting on the surface of the earth since it rose above the waters, have fashioned it into its present form. We have old oceanic valleys which were formed at the bottom of the sea in times anterior to the elevation of our continents. Such is the great valley of the Caledonian canal, which existed nearly in its present form at a period anterior to the conglomerates of the old red sandstone. We have longitudinal valleys formed along the line of junction of two contiguous formations, simply by the elevation of their beds. To this class belong some of the great longitudinal valleys of the Alps. We have other valleys of more complex origin; where the beds through which the waters now pass have been bent and fractured with an inverted dip at the period of their elevation. Such is the valley of Kingsclere, described in a former volume by Dr. Buckland. We have valleys of disruption, marking the direction of cracks and fissures

produced by great upheaving forces. Such are some of the great transverse valleys of the Alps. Of valleys of denudation our island offers a countless number. Some are of simple origin : for example, the dry combes and valleys of the chalk, which appear to have been swept out by one flood of retiring waters during some period of elevation. Others are of complex origin, and are referrible to many periods, and to several independent causes. Lastly, we have valleys of simple erosion : such are some of the deep gorges and river channels in the high regions of Auvergne, excavated solely by the long continued attrition of the rivers which still flow through them.

I should not have dwelt so long upon this subject, had it not occupied a large portion of our attention during the past year; and I may be pardoned for entering a record of my own views on a question of no small complexity, and on which there is still much contrariety of opinion.

During the past year we have been presented with several memoirs describing formations superior to the chalk : which I shall also notice in the order of the subjects, without any regard to the time when they came before us.—In a Paper by Dr. Fitton on the structure of a portion of the low countries in the north of France, among other interesting details, is a description of three of this great class of formations. He points out deposits in the neighbourhood of Calais, Antwerp, and Tongres, which resemble the Crag of Suffolk. He compares the sands of St. Omer, Cassel, and Lille, with the sands which overlies the chalk in the London basin : and he states that the arenaceous beds of the hill of Cassel (like similar beds at Brussels) contain large suites of fossils, generally agreeing with those of the London clay. Lastly, he describes in detail the structure of St. Peter's Mount near Maestricht, and shows that the inferior beds form a gradual passage into the white chalk on which they rest; while the upper beds bear marks of degradation and mechanical interruption, and offer no indication of a passage into the superior sands. And he adds that, out of more than fifty species of organic remains collected by himself from this deposit, not more than ten are found in our best catalogues of chalk fossils.

I may here remark, that the suite of fossils in the Cassel sands throws no difficulty in the way of their comparison with the lower tertiary sands and plastic clay of England. The terms London clay and Plastic clay may be preserved as convenient mineralogical designations. They mark, however, nothing more than the subdivisions of one great deposit between the lower and the higher members of which there is no line of zoological separation. In the London and Paris basins, there is a great chasm between the secondary and tertiary systems to be filled up by the future labours of Geologists. The Maestricht beds are so nearly related to the formation on which they rest, that they may be regarded as the last term of that new series of deposits which we hope hereafter to find interpolated between the *calcaire grossier* and the chalk.

A Paper by Mr. Murchison makes us acquainted with the structure



of the tertiary formations on the southern flank of the Alps between the Brenta and the Piave. They are divided into two great natural groups exhibited in two zones:—an outer zone containing shells which seem to be nearly identical with the well known fossils of the newer tertiary Sub-Apennine formations;—an inner and inferior zone containing in its higher portions a few shells resembling those of a part of the Bourdeaux basin, while its lower beds are distinguished by innumerable organic remains, more than half of which seem to be specifically identical with those of the *calcaire grossier* or London clay. These lower beds on the banks of the Brenta are inclined at  $70^{\circ}$  or  $80^{\circ}$ , and are based upon a nummulite rock, which is absolutely vertical and conformable to the *scaglia* (containing ammonites and belemnites), and together with it rises into peaks of considerable height on the extreme border of the chain: and there is no conglomerate or other mechanical degradation of the older rocks, to mark the junction of the secondary and tertiary systems. Some notion may be formed of the enormous thickness of these deposits from the statement, that a transverse section (from Asolo to Possagno) through beds of only a part of this series, inclined at various angles from  $25^{\circ}$  to  $40^{\circ}$  and exhibiting no inversions of dip, is not less than five miles in length. One important consequence seems to follow inevitably from these details: the last epoch of elevation of the neighbouring mountains must have commenced during a period posterior to the tertiary formations described in this memoir.

In three Papers, recently presented by Mr. Murchison and myself to this Society, we have endeavoured to establish a series of similar conclusions, by induction from the phenomena observed on the flanks of the Salzburg and Bavarian Alps. I will not give you any analysis of details, so lately the subject of discussion in this room. I may, however, briefly recall your attention to the results which we consider best established and of most importance. We have shown that several transverse sections from the central axis of the Alps to the basin of the Upper Danube would present a succession of phenomena in very near accordance with those of other transverse sections from the same axis to the tertiary formations at the other base of the chain in the north of Italy. On both sides of this chain, after passing over the great secondary calcareous zones, we meet with the lower tertiary strata,—always highly inclined, sometimes vertical, and occasionally conformable to the beds of the older system. We contend that this remarkable symmetry confirms the hypothesis of a recent elevation of the Eastern Alps; and makes it probable, independently of arguments derived from organic remains, that the tertiary deposits of the Sub-Apennine regions and of the basin of the Upper Danube belong to one period of formation.

Thick masses of strata full of organic remains, and often occurring at low levels near the northern foot of the chain, are sometimes also found (e. g. in the valley of Gosau) in unconformable positions, caught up among the serrated peaks of the Alps, four or five thousand feet above the level of the sea. Such a disjunction of corresponding strata (and I may observe that the argument bears not upon their

exact age), is inexplicable on any hypothesis which rejects the theory of elevation. We have concluded, chiefly on zoological evidence, that the unconformable beds of Gosau are more recent than the chalk. We believe that they contain neither ammonites nor belemnites, nor any other known species of secondary fossils; and on the whole we regard them as a term of that unknown series of formations which may hereafter close up the chasm between the lowest beds of the Paris basin and the chalk.

We have pointed out the limits of the old chain of the Salzburg and Bavarian Alps, and traced the direction of its valleys anterior to the tertiary epoch: and we have described a great deposit of lignite far up the valley of the Inn, containing freshwater and marine shells, which seem to connect it with the period of the London clay. We have further shown, that there are within the basin of the Upper Danube two or three higher zones of lignite separated from each other by sedimentary deposits of enormous thickness.

The tertiary system of Bavaria is shown to pass into, and to be identical with, the *molasse* and *nagelfluë* of Switzerland. The higher part of this series must therefore (on the system of M. Studer) be of the same age with some of the formations of the Sub-Apennines. We have proved that enormous masses of sandstone and conglomerate many thousand feet in thickness, stretching from the base of the Alps to the plains of the Danube, are chiefly derived from the degradation of the neighbouring chain—that many of these masses cannot be distinguished from the newest detritus which lies scattered on the surface of the earth—that in their prolongation into Switzerland they sometimes contain bones of mammalia—that they are regularly stratified, and alternate with beds containing marine shells—and that they cannot have been caused by any transient inundation.

Finally, we point out the probable effect of debacles which took place when the basin was deserted by the sea. We show that the excavations produced by the retiring waters have been augmented by the bursting of successive lakes, of which we found traces in all the upland valleys of Bavaria; and that these excavations have been since carried on by the erosive power of the streams which roll down from the sides of the Alps to the plains of the Danube.

The greatest number of tertiary formations hitherto described appear to have been produced either in estuaries or mediterranean seas; the depth of which, however considerable, was probably much less than that of the wider oceans wherein some of our secondary rocks have had their origin. These circumstances tend to explain the frequent alternations of marine and freshwater beds in the tertiary seas; and they satisfactorily account for the appearance of land shells, lignite, and other terrestrial remains, drifted, at many different periods, into the regular marine deposits of the tertiary groups. By the help of these alternations are certain species of marine and freshwater shells demonstratively shown to have been contemporaneous. And when this conclusion is once established, it may be applied to determine the age of those lacustrine formations which have never communicated with the sea.

In this way it has been shown that the enormous lacustrine deposits of Aix in Provence, of the Cantal, of the Limagne d'Auvergne, and of other districts in the south of France, belong to the period of the great tertiary system of the Paris basin. I have no time even to allude to the important works connected with these subjects, which we owe to the naturalists of France : and the two Memoirs of Messrs. Lyell and Murchison, "On the tertiary deposit of the Cantal," and "On the freshwater formations of Aix in Provence," have been already published\*. I am not, therefore, called upon to give any regular analysis of their contents. I may, however, be permitted to recall your attention to the enormous thickness of a regular succession of deposits described by these gentlemen in a section extending from the hills above Aix to the coal works of Fuveau. We have at the base of the section a great system of alternating beds of limestone and shale containing many seams of coal, some of which are worked by perpendicular shafts 500 feet in depth. Over this succession of beds, come vast groups of strata forming ranges of hills composed of limestone, shale, and sandstone. These are surmounted by thick deposits of red marl and fibrous gypsum, and by vast masses of conglomerate. Finally, over the conglomerate comes a series of beds conforming to the more ordinary tertiary type ; remarkable for the regularity of their deposition, and for the beautiful preservation of the shells, the fishes, and even the insects contained in them. Such are the mineralogical characters of the lower members of this great series, that they have been referred (even by expert naturalists who had not sufficiently examined the organic remains) to the old coal formation and the new red sandstone ; but from top to bottom their fossils are exclusively tertiary and lacustrine. At the same time we attempt in vain, by joining in imagination the prominent elevations of the older rocks in the neighbouring regions, to restore the former barriers once containing that great body of water within which these deposits had their origin.

The Paper on the Cantal brought before us a series of facts no less striking and impressive. In this high region are the escarpments of an old lacustrine formation, nearly 500 feet in thickness, full of freshwater shells, many specifically identical with fossils of the basins of Paris and of the Isle of Wight : but here, as in the former case, there are no barriers to mark the limits of the lake within which this deposit was once confined. The same region also bears the impress of another succession of phenomena ; for within the area of this ancient lake, and after the solidification of the beds of marl formed in its waters, burst forth one of those great trachytic eruptions which mark all the neighbouring parts of France. So that we now find beds of basalt, trachytic breccia, and other old volcanic rocks, overtopping, on the side of one valley, by more than 800 feet, the highest lacustrine rocks through which they have breached a passage to the surface of the earth : and in the neigh-

\* See Edinburgh New Phil. Journal, Oct. 1829 ; and *Annales des Sciences Naturelles*, tom. xviii. p. 172.

bouring region the same old volcanic rocks have risen to several times that elevation.

When we examine the upper rock marl of the Isle of Wight, we see a deposit separated from us and the things about us, only by a few feet of transported gravel. The outline of the country might have been remodified and the gravel formed by some transient inundation. We have therefore no measure of the time which may have elapsed since the first existence of the phenomena before us. If, however, we examine the shells in the rock marl, we find that few, if any, belong to species existing in our lakes or rivers. We cannot believe that there is so great a violation of continuity in the forms of animated nature, except in subordination to nature's laws; and we feel almost forced to seek for a solution of our difficulties amidst the ideal revolutions of former ages.

But how differently is the history of the same great period told off among the volcanic mountains of the Cantal and Auvergne! Great lacustrine formations, of the same age with the rock-marl of the Isle of Wight, are there proved by their organic contents to have been formed and solidified at a time anterior to the trachytic eruptions which upheaved and desolated the whole surface of the country. How long these great eruptive forces were in action it is useless to conjecture; but they were followed by ages of repose, during which the surface of the land was reformed, and deep valleys were excavated by the erosive power of water. A new period of volcanic agency succeeded, marked by domes of cinders and scorix remaining to this day almost unchanged, and by streams of lava which may be traced from them into the existing valleys. And even these last operations, however recent in the order of geological events, were anterior to the records of history; so that we can still only approximate to their date, by a careful comparison of the effects since produced upon these streams of lava by the destructive power of the elements.

A description by Mr. Murchison of the lacustrine strata and fossils of Ceningen is the last communication, connected with tertiary formations, I am called upon to notice. He shows that this deposit consists of horizontal beds of a considerable aggregate thickness, laid bare in quarries on the side and near the summit of a ridge of hills the base of which is washed by the waters of the Rhine—that they do not alternate with the *molasse* but repose upon it unconformably—and that from top to bottom they are of freshwater origin. He enumerates in detail a great variety of fossils (such as insects, plants, shells, fishes, tortoises, and mammalia,) discovered at different times in these quarries; and he adds a description (from the pen of Mr. Mantell) of a fossil fox not to be distinguished from the *Vulpes communis*, found in the middle beds of this system. From all these geological details, as well as from the position of the strata, he concludes that they belong to a very recent tertiary period. At the same time, the waters of the Rhine descend from the lake of Constance at a level no less than 600 feet below that of the old lake in which the Ceningen beds origi-

nated ; and there is not in the present outline of the country any indication of the surface over which they once extended.

Such, Gentlemen, have been the prominent subjects of discussion during our meetings of the past year. Before I proceed to other questions, let me express my thanks to Mr. Vernon, for the zeal with which he has investigated, and the fidelity with which he has described, a deep excavation at North Cliff in Yorkshire. Under the ancient gravel of the district are found regular deposits of river silt, containing bones of the mammoth, the horse, the urus, the rhinoceros, the wolf, the ox, and deer ; mingled with thirteen species of land or lacustrine shells, absolutely identical with those now living in the neighbouring district. Phænomena like these have a tenfold interest, when regarded as the extreme link of a great chain, binding the present order of things to that of older periods in which the existing forms of animated nature seem one after another to disappear.

Twenty years are not yet passed away since MM. Cuvier and Brongniart first published their researches on the geological structure of the Paris basin. The innumerable details exhibited in their various essays ; the beautiful conclusions drawn from unexpected facts ; the happy combination of mineralogical and zoological evidence ; the proofs of successive revolutions, till then unheard of in the physical history of the earth—all these things together, not merely threw new light on a subject before involved in comparative darkness, but gave new powers and new means of induction to those who should in after times attempt any similar investigations.

Mankind are, however, dazzled and astonished by great discoveries, as well as guided and instructed : and for some years after the publication of these admirable works, the naturalists of various countries, whose attention had been so loudly called to the deposits above the chalk, saw in them only a repetition of what was already described, and of which the true type was in every case to be sought among the formations of the Paris basin. Investigations conducted in this spirit sometimes ended in disappointment. But this was not the spirit recommended in the incomparable Essay of Cuvier\* ; for after exhibiting the true method of geological induction, and describing the intense and almost tormenting interest with which he had followed out his own investigations, he points to the long series of deposits in the Sub-Apennine hills, and states his conviction that in them lies concealed the true secret of the last operations of the ocean.

Since that discourse was written, much has been done ; but much more still remains to be done. It has been my pleasing task to place before you the labours of some of our own body in illustrating the recent geological periods in the history of the earth : by such details alone can we expect to comprehend the more intricate phænomena of still older periods, and to connect them with the great physical laws by which all matter is governed.

\* See *Discours Préliminaire*, p. 112, 1st edition.

Considered in the most general point of view, without any regard to the lacustrine beds which are perhaps local or accidental, the tertiary groups of the Paris basin may be described as a great complex system of deposits belonging to one protracted zoological period; characterized by extinct genera of mammalia, and by innumerable marine shells; but affording very few species by which we can connect them either with the chalk, or with the formations of our neighbouring seas. Their position is therefore entirely insulated; and by what new links they may be connected with the physical events which went before them and followed after them, can only be determined by a long series of observations. I have already pointed out the source from which some of the older links may hereafter probably be supplied. Of the same palæotherian age, and in the same insulated position, are the tertiary deposits of Hampshire, and some of the great lignite formations in the north of Germany.

The next group of the tertiary system is ill defined, and still but imperfectly understood. Some members of it are seen on the banks of the Loire, and have formed the subject of a late important memoir by M. Desnoyers; and the same portion of the series is represented on the eastern coasts of England, by the beds of Crag overlying the London clay. It contains, like the former division, the bones of many mammalia, some of extinct, and some probably of living species; but the remains of the extinct animals do not belong to the palæotheria of the older period, but to the mammoth, the rhinoceros, and other animals, of which the bones are found so constantly in the superficial gravel. To the fossil shells of this division the same observations may be applied: many belong to species which are unknown, and perhaps extinct; others cannot be distinguished from the living shells of the neighbouring seas.

A third division of the system may comprehend all the higher Sub-Apennine deposits; distinguished by the bones of mammalia in still greater abundance, and by the number and beauty of the fossil shells, many of which are of living species. It is of enormous thickness in some of the low regions at the base of the Apennines; and it probably extends over a considerable portion of the basin of the Danube, and over the plains beyond the eastern termination of the Alps. I have, however, no time, nor do I possess information, to give any detailed account of its distribution.

During the periods in which the two last tertiary groups were elaborated in the sea, there must have been deposited on the land, in caverns, in fissures, and in beds of superficial gravel, many bones of the same species of animals by which those groups are characterized: and during the same periods may have originated in inland lakes some of the deposits of which we now only see the traces in masses of lacustrine marl found in various countries resting unconformably upon the older strata.

It is impossible with our present knowledge, to form even a conjecture respecting the subdivisions into which the whole tertiary series may finally be separated. I am only anxious, in the mere out-

line I am now attempting, to describe the successive groups above the chalk in terms the most general, and in divisions the most comprehensive; especially, as they appear in connexion with our labours of the past year.

I must, however, notice one more group in the succession of marine deposits, before I can complete the ascending series and reach the limits of history: the name *tertiary* cannot perhaps with propriety be applied to it, as the animal remains contained in it are almost exclusively of the species now living in the nearest seas. To this class we may refer certain shelly deposits in the West India Islands—on the shores of the Red Sea—and on various parts of the shores of Italy, Sicily, and Spain. Their position, as might be expected, is generally low. But near the focus of volcanic action they rise to more considerable elevations: in proof of which I need only state, that beds of shells are found on the mountains of Sicily three thousand feet above the level of the Mediterranean, and of the same species with those now living in its waters\*.

Such are the steps by which we ascend through the divisions of the tertiary period. I need not, however, inform you that we can seldom determine their relations by the mere evidence of superposition. Most frequently they appear in detached masses, the age of which can only be known by their fossils. This kind of evidence is, however, sometimes brought before us in a manner at once the most complicated and the most conclusive. It is to the labours of MM. Deshayes, Basterot, and other expert naturalists, who are devoting their talents and time to the completion of great works on the organic forms of the several tertiary groups, that we must look for information, which in the end may give us the means of a safer and wider induction.

With the exception of an interesting notice by Dr. Buckland of the occurrence of agates in the dolomitic strata of the Mendip Hills, not a single memoir has been read before us during last year, on the mineralogical structure of any part of the British Isles. I do not mention this without regret; for while any part of the structure of this country is unexplored, we have left unfinished that task, to perform which was the first great object of our association. The work of Mr. Phillips on the strata and organic remains of the Yorkshire coast offers, however, a splendid contrast to this portion of our year's productions. The clearness of the descriptions, the accuracy of the sections, the figures of more than 400 fossils faithfully arranged according to their grouping in the formations between the new red sandstone and the chalk, combine to make it one of the most valuable and instructive Essays in our language.

Much, Gentlemen, remains to be done, before the structure of the various formations of the British Isles can safely be appealed to

\* This important fact was communicated by Mr. Lyell, and is described by him in a work now in the press.

as one of those complete middle terms of comparison, by help of which the disjointed fragments of a former world may in imagination be reunited. Respecting the perplexing phænomena of the Crag beds on the coast of Suffolk, we are greatly deficient in information. The accounts of all our tertiary strata, however excellent at the time they were written, must be entirely remodelled. Even the history of the oolitic series (the boast of English geology, and the type to which foreign naturalists are attempting to conform some of their own secondary rocks) is defective. We know, in admirable detail, the formations near Bath. On the coast of Yorkshire Mr. Phillips has left us nothing to desire. But a promised Memoir on the beautiful phænomena near Weymouth, after many years of expectation, is still unwritten; and a detailed transverse section through the wide oolitic beds of Northamptonshire is among our most important desiderata.

Something is left to be done in illustrating the upper part of the new red sandstone. It is here that the poverty of our secondary rocks offers a striking contrast to the riches of the coeval rocks on the flanks of the Vosges and on the banks of the Neckar; and this very poverty makes every scrap of information, whether derived from mineralogical or organic characters, of importance in assisting us to complete this broken part of our secondary series.

Even the history of our coal formations is not yet perfect. The association of the coal and mountain limestone of Northumberland has not been well explained. The great corresponding deposits of Cumberland are undescribed: nor does it appear in our published works, that coal is found alternating in the North of England with all parts of the mountain limestone group; and that beds of coal are worked in several places, resting upon transition slate, and surmounted by the whole limestone series. More than half of Ireland is a blank on our geological maps; and on many of the transition districts of England our information is lamentably defective.

The study of our older deposits is indeed difficult and toilsome, and unenlivened with the frequent occurrence of organic bodies. But no country, hitherto described, shows a more splendid series of phænomena to illustrate the intrusive agency of crystalline rocks; and to exhibit the great successive internal movements by which our continents have been elevated, and brought under those laws of degradation which have fashioned them into their present forms. In these investigations there is still a rich spoil ready for any one who will have the courage to stretch out his hands to grasp it. A part of it I have myself gathered among the mountains of Cumberland, with no small labour; which I shall count for gain, if I may be permitted, hereafter, to lay it up in the storehouse of this Society.

Leaving, however, the subject of British geology, I must call your attention to those Papers which, during our sessions of the past year, have described the general phænomena of secondary rocks.—On the secondary formations of the Netherlands we have heard some interesting remarks in a recent Paper by Dr. Fitton,



above quoted. He describes the structure and distribution of the chalk, the firestone, and the green and ferruginous sands; shows their discordant position over the coal-measures; and indicates the characters, both in which they differ and agree with the corresponding members of the English series.

In a Paper on the geology of the shores of the Gulf of La Spezia, beautifully illustrated by sections and drawings, Mr. De la Beche describes a long series of stratified and unstratified rocks. Among the former may be enumerated, beds of clay, sandstone, and conglomerate, supposed to be tertiary; beds of *macigno*; the marble of Porto Venere; the crystalline limestone of Capo Corvo, &c. among the latter, diallage rock, serpentine, mica schist, &c. He endeavours to show, from the structure of the district and the fossils of the neighbouring rocks, that the marble of Porto Venere may belong to the age of the oolitic series; and that the diallage rocks and serpentine are a prolongation of the system of southern Liguria, and have been protruded by igneous action among the depository rocks, after the period of the oolites.

Among the contributions to our knowledge of the structure of foreign secondary deposits, I must lastly notice the communication of Mr. Murchison on the bituminous schist and fossil fish of Seefeld. This singular rock rises to a great elevation among the bare calcareous peaks of the Tyrolian Alps, and contains such a quantity of bituminous matter, probably derived from the animals imbedded in it, that some of its strata are broken up and exposed to a process of distillation, by which a great quantity of what may be called mineral fish oil is extracted for economical use. Among the fossil fish M. Valenciennes of Paris discovered at least four species; one a *clupea*, and three distinguished by quadrangular scales, without articulating points, and resembling the *Esox osseus*; but differing from that genus, both in the form of the tail and the position of the fins.

There is a large family of fish, made up of many genera and species, and distributed from the old red sandstone to the magnesian limestone, belonging to the order *Malacopterygii abdominales*, and particularly distinguished, like the *Esox osseus*, by a pointed tail, the lower side of which alone is supplied with rays. It is obvious from this description that the Seefeld fish are not comprehended in that family: and as they are not identified with the fossils of any known formation, we must consider their place as still undetermined. This is at least a safe conclusion; for mineralogical indications in the calcareous regions of the Alps are of very small value in determining the question.

During the past year, we have received from Dr. Buckland several additional notices, drawn up with his well known sagacity and singular felicity of illustration, on the characters and distribution of various specimens of coprolites. The results of his inquiries are published in the last Part of our Transactions; and on that account I am precluded from any further remarks upon them. They belong, indeed, to important discoveries of the former year, and have al-

ready been noticed in the Anniversary address of my predecessor in this chair.

From the same pen we have also a description of the bones of the Iguanodon and other large reptiles, discovered at Sandown Bay in the Isle of Wight and near Swanwich in the Isle of Purbeck. In both localities the formation is the same with that of the sandstone of Tilgate Forest, in which Mr. Mantell first discovered the remains of the Iguanodon, an herbivorous reptile of extraordinary stature. Dr. Buckland describes an external metacarpal bone (six inches in length, five inches in its greatest breadth, and six pounds in weight) of the right foot of some reptile, supposed, from the stratum in which it is found in Sandown Bay and from the bones with which it is associated, to be an Iguanodon. It is in linear dimensions twice as large as the corresponding bone of a large elephant: and we must consider the small proportion which the legs of a reptile bear to the length of its body, in order to form any notion of the gigantic proportions of this quadruped.

Finally, I have to notice a communication from Mr. Hennah, containing a systematic and descriptive catalogue of the fossils of the transition limestone of Plymouth, read at our last meeting.

Such, Gentlemen, have been the memoirs presented to us since our former Anniversary. I have brought them before you in that order in which they seem to cast light upon each other; and I have indulged in no comments but such as sprang immediately from the subjects themselves.

I rejoice in the number and activity of our provincial institutions; and still more, that the same spirit which has of late years induced so many Englishmen to combine for the furtherance of natural knowledge, is extending to our colonies in America and Asia. From the labours of so many ingenious men, united for the same end, and with opportunities for observation so widely different, the happiest results may be anticipated.

I should wish to say something on the general structure of the Alps; and to describe the speculations of one of our Foreign Members and best fellow-labourers on the different epochs of elevation. These are inviting topics, to which, on a future occasion, I may perhaps return: but had I even time for their discussion, it would not be well for me, at present, to trust myself in so wide a field.

Of the various works poured out during the past year from the German and French press, on subjects connected with geology, it is impossible for me to offer an analysis or even an enumeration. Most of them are the productions not only of great talent, but of great good sense; not only of great labour, but of labour happily directed. And it is no small matter of pride to this Society, that its researches have been highly valued by the naturalists of the Continent. They have not given their praises to us grudgingly; but have sometimes scattered them with a lavish hand; and have, I fear, awarded to us higher honours than we ourselves can be

conscious of deserving. I think I could point out more than one Essay, in which, during the past year, the geologists of the Continent have injured their descriptions of secondary formations, and impeded their own inductive powers, by fixing their eyes too steadily on the types of the English series.

I congratulate you on the completion of the geological map of Germany by an illustrious naturalist, who for many years has devoted, and continues still to devote, the best efforts of his life to the promotion of our science. He has not affixed his name to this great work, and he perhaps still regards some parts of it but as an approximation. The elaborate and accurate maps of north-western Germany by Professor Hoffmann, and of the Odenwald and the neighbouring districts by Dr. Klipstein, belong also to the productions of the past year\*. Professor Hoffmann's map is to us of peculiar interest; not merely from the extent and intricacy of the country it delineates; but also from the number of secondary formations which it represents, in perfect conformity with the subdivisions adopted in our own geological maps. Works of this kind are of inestimable value: they are the embodied results of observations without number, directed to one object; and, when well performed, may be regarded as the last generalizations from facts exhibited in their clearest and simplest form. But more than this,—they guide us to the fountain-head of information, and lead us to still more general conclusions, by giving us at every step of our way the means of comparison with the structure of other regions†.

To some admirable works on natural history, now in progress, which bear more or less directly on our subject, I have no time to allude. But I may point, with peculiar satisfaction, to the advancement of the work of M. Adolphe Brongniart on fossil plants, and to the appearance of a new number of the work of Goldfuss on organic remains. By the continued labours of these excellent naturalists, we are supplied with new terms of geological comparison, and new means of legitimate induction. I am happy also to announce the approaching publication of a general index to the volumes of Mr. Sowerby's "Mineral Conchology," in which the errors incidental to such a work will be corrected, and all the fossils arranged according to their position in the successive groups of the British strata. Such an Index has long been wanted; and its execution will be an advantage above all price to the student of secondary geology.

\* Dr. Klipstein has also executed a geological map (not, I believe, yet published) of the districts north of the Main; on the same scale, and of the same extent, with the Odenwald map.

† The geological maps of Germany are sold by Simon Schropp and Co. of Berlin. I take this opportunity of observing, that the difficulty of procuring copies of works like these has long been a matter of complaint. Of the excellent geological map, by MM. Oeynhaus, von Dechen, and De la Roche, though published in 1825, not a single copy has, I believe, yet found its way into the shops of any of our geographers. I only procured it myself at Berlin.

Each succeeding year places in a stronger point of view the importance of organic remains, when we attempt to trace the various periods and revolutions in the history of the globe. Crystalline rocks are found associated with the strata of almost every age; and the constant laws of combination which have produced a certain mineral form in rocks of one era, may produce it again in another. Nearly all the modifications of structure in rocks called primary are also found in secondary formations: and among tertiary deposits we sometimes find millstone-grit, red marl with fibrous gypsum, red conglomerates, compact, subcrystalline, and oolitic limestone; in short, all the distinguishing characters of secondary formations. The great barriers, which the fancy or ingenuity of geologists has at different times set up between the mineral productions of successive periods, have been thrown down, one after the other. I do not deny the importance of mineralogical characters; I only mean to assert that, taken by themselves, they are no certain indications of the age of any deposit whatsoever.

In reasoning from organic remains, by the succession of large groups alone can we establish any safe induction. Positive rules founded on the presence of particular genera or species are of comparatively small value. But the mind becomes wearied and bewildered by the endless succession of individual forms, and delights to take refuge in some generalization: and generalizations would be excellent things if we could be persuaded to part with them as easily as we form them. They might then be used like the shifting hypotheses in certain operations of exact science, by help of which we gradually approximate nearer and nearer to the truth.

In England, and many other parts of the north of Europe, nummulites are found only in tertiary rocks, and orthoceratites only in those of the transition periods; but in the secondary limestone of the Alps we find, abundantly, both orthoceratites and nummulites. Ammonites and belemnites have not yet been found among the strata called tertiary. But should the chasm between the secondary and tertiary systems ever be filled up, it may be as difficult to draw any line between them, as it now is to draw the line between the transition and secondary series. Belemnites descend no lower than the lias. Ammonites descend among the transition rocks; and it has been remarked, that in all the deposits under the lias, the concamerations of this genus are of a simpler figure (being marked at their junction with the outer shell only by lines undulating or in zig-zag,) than those of the corresponding fossils in the higher formations. As far as regards the English carboniferous and transition series, this rule is true. But the only ammonite I ever found in the magnesian limestone had those suture-like markings which distinguish this genus in the upper secondary beds. The *producta* is not found above the magnesian limestone (*zechstein*): it occurs abundantly in the lower part of that formation, and it also abounds among the fossils of the transition periods. Certain plants are eminently characteristic of our coal formations; but in England they also occur in the sandstone beds which alternate

with the mountain limestone. Near Magdeburg they are found in grauwacké; and M. Elie de Beaumont has, on the south flank of the Alps, found the same vegetable forms in beds of the age of our lias. Positive and negative rules like these, when kept in subordination to new facts, are of the greatest value; for they record in a few words the result of many observations.

When we examine a series of formations which are in contact, we constantly find them passing into each other: and when we place the groups of fossils derived from the successive terms of the series in the order of superposition, their passage is still more striking. I do not mean by this to vindicate the transmutation of species; because that doctrine is opposed by all the facts of any value in determining such a question. Neither do I assume any positive law of continuity such as may be predicated of a formula in exact science. I only wish to state a fact of general observation. We sometimes, however, find that this order in the works of nature is interrupted; a leaf seems to be torn out from the volume of her history. At the same time all the connecting links, which bind the successive mineral masses to each other, are broken; and their separation is marked by contortions and disruptions, by heaps of conglomerate, and by all the other proofs of violent internal commotions. But these internal commotions have not been universal: and when we get beyond their operation, we recover the lost page in the history of the world, as it is told in the succession of animal forms, and every thing is again reduced to harmony and order. I do not intend to deny that there may have been certain great epochs of elevation, of such wide-spreading violence as to affect every living thing on the face of the earth. This is a mere question of fact, and to be resolved solely by observation. I only wish to vindicate a principle which we know from experience to be of very extensive application, and to which I have before alluded in this address. I may therefore again be permitted to enforce it by a specific illustration.

In many parts of the west of England, the lias is separated from the coal measures only by a few hundred feet of red sandstone and conglomerate not containing the vestige of an organic fossil. It might be supposed (and such a supposition would not be new) —that the red sandstone and conglomerate were formed during some short period of confusion produced by the dislocation of the older rocks—that after a time the sea again became tranquil—and that the fossils of the lias were called into being, upon the ruins of an older world, by a new fiat of creative power. Nor should I object much to such a hypothesis, if it were only regarded as a mere explanation of local phenomena. But the fossils of the coal measures bear no resemblance to the fossils of the lias. There is, therefore, such a break of continuity, that we are forced in imagination to supply many new groups of organic forms before we can bring the order of succession into accordance with the known analogies of nature. If we continue our investigations to the north of England, we see the coal measures less disturbed and the dolomitic conglom-

merates less developed. We find, at the same time, new divisions of the dolomites ; some of which abound in organic remains, having a resemblance to the fossils of the carboniferous strata, and being in a few instances specifically the same with them. We also find among them many new species of organized beings. Still the sequence is incomplete ; the fossils of the dolomitic beds make but little approach to the fossils of the lias : and no part of the British Isles has hitherto supplied us with the intervening terms of the series. But if we extend our inquiries to the secondary formations of Germany and France (particularly in the regions of the Vosges, or on the banks of the Neckar), we meet with a solution of our difficulties. In the place of our barren deposits, between the magnesian limestone and the lias, we have three great formations, each characterized by its suite of fossils ; and among them we find a series of zoophytes, and shells, and great reptiles, gradually leading us to the organic types of the lias and the oolites. In proof of what I am stating, I need only refer you to that part of our collection, which we owe to the liberality of M. Voltz, whose labours have thrown so great a light upon this interesting chapter of the physical history of the earth.

In this way, by successive but secure inductions, we resolve our first difficulty ; and are no longer startled at the change of organic types, in the west of England, between the coal measures and the lias. For between the times of their deposition, there were completed at least five great geological periods ; each distinguished by its own group of animals, and each, therefore, probably continued during a long succession of ages. I must, however, forbear : the subject is boundless ; but our time allows not of further details.

It is, I think, a matter of regret that there have not appeared, from time to time, in our language, works placing clearly before the world the progress of geology, the laws of its induction, and the subjects of its speculations. Such works, however, demand more than common powers,—a grasp of details only acquired by practical experience ; and habits of mind fitted for the exhibition of them, in their most simple and general form. But above all, they require a moral elevation, and a dignified forbearance, to free the mind from those attractive visions of ancient cosmogony, and those seductions of fanciful hypotheses, by which the history of geology has so often been degraded.

It is indeed true that an essay representing our science as it now is, must in a few years be left at a distance by the progress of new discoveries. At the same time, to no works in the history of physics do we revert with more pleasure and instruction, than to those which record the progress of discovery, and the early approximations to general truth. Their lessons of wisdom remain ; and we look back to them with veneration, as to ancient monuments, which, however rude, or ill suited to the fashion of our day, still bear the stamp of the genius that produced them.

But, Gentlemen, if our science has not been adorned in this country so much as we might have wished by its monuments of wisdom, it has been disfigured by its monuments of folly. There have issued from the English press, within a few years, such dreams of cosmogony as I believe find no parallel in the recent literature of continental Europe. It would be in vain to point out to such authors the nature of our data, or the method of our inductions; for they have a safer and a readier road to their own conclusions. It would be in vain to tell them—that the records of mankind offer no single instance of any great physical truth anticipated by mere guesses and conjectures—that philosophic wisdom consists in comprehending the last generalizations derived from facts each of which is only known by experiment and observation; and in advancing, by such means, to those general laws by which all things are bound together. They seem not to know that inventive power in physics, unlike inventive power in works of art or of imagination, finds no employment in ideal creations, and only means the faculty by which the mind clearly apprehends the relations and analogies of things already known; and is thereby directed and urged on to the discovery of new facts, by the help of new comparisons—that the history of all ages (and I might add, the written law of our being, where it is declared that by the sweat of our brow shall we gather up our harvest) has proved this way of slow and toilsome induction to be the only path which leads to physical truth.

Laws for the government of intellectual beings, and laws by which material things are held together, have not one common element to connect them. And to seek for an exposition of the phænomena of the natural world among the records of the moral destinies of mankind, would be as unwise, as to look for rules of moral government among the laws of chemical combination. From the unnatural union of things so utterly incongruous, there has from time to time sprung up in this country a deformed progeny of heretical and fantastical conclusions, by which sober philosophy has been put to open shame, and sometimes even the charities of life have been exposed to violation.

No opinion can be heretical but that which is not true. Conflicting falsehoods we can comprehend; but truths can never war against each other. I affirm, therefore, that we have nothing to fear from the results of our inquiries, provided they be followed in the laborious but secure road of honest induction. In this way we may rest assured that we shall never arrive at conclusions opposed to any truth, either physical or moral, from whatsoever source that truth may be derived: nay rather (as in all truth there is a common essence), that new discoveries will ever lend support and illustration to things which are already known, by giving us a larger insight into the universal harmonies of nature.

Had the authors to whom I have alluded, contented themselves with pointing out the errors of our logic, and the fallacies of our induction, they might, perhaps, have done us some service. For it cannot be denied that we have sometimes lost ourselves amidst the strange forms of nature which have started up before us, during our wanderings among the monuments of an older world: and in the

records of our labours, a critical eye may perhaps sometimes discover that the modesty of our facts is but ill assorted with the boldness of our conclusions.

I should have been well content to have ended with these general censures. But during the past year there has been sent forth, by one of our own body, "a New System of Geology, in which the great revolutions of the earth and of animated nature are reconciled at once to modern science and to sacred history:" and to this title I will venture to add,—in which the worst violations of philosophic rule, by the daring union of things incongruous, have been adopted by the author from others, and at the same time decorated by new fantasies of his own. I shall not stop to combat the bold and unauthorized hypothesis, that all the successive formations of the old schistose rocks were called into being simultaneously by a fiat of creative power anterior to the existence of creatures possessing life: nor shall I urge, that among these primitive creations of the author, are mountain masses of rock formed by mechanical degradation from rocks which preceded them, and beds of organic remains,—placed there, if we may believe his system, in mere mockery of our senses;—neither shall I detain you by dwelling upon the errors and contradictions which are scattered through the early pages of his volume. On this part of the "New System" all criticism is uncalled for here; for it soars far above us and our lowly contemplations. Its character is written, and its very physiognomy appears in that dignified and oracular censure which he himself has quoted from the works of Bacon: "*Tanto magis hæc vanitas inhibenda venit et coercenda, quia ex divinorum et humanorum male-sanâ admixtione, non solum educitur philosophia phantastica, sed etiam religio hæretica.*" "This vanity merits castigation and reproof the more, as from the mischievous admixture of divine and human things, there is compounded at once a fantastical philosophy and an heretical religion."

All these things, Gentlemen, I shall pass over: but the author has stood forward as the popular expositor of the present state of secondary geology; of that very portion of our science, which has for so many years employed the best efforts of our Society. This part of the work appears not to contain one original fact, or the result of one original investigation: and of this we do not complain. We have, however, a right to look to it for information which shall not repeat exploded errors; but shall make a near approach to the level of recent observations. But is this the case in the work before us? Unquestionably not. All the old errors in the arrangement of the English strata, between the chalk and the oolites, are unaccountably repeated;—errors which have been corrected since 1824, in our Transactions, in English and Scotch philosophical journals, and in various independent works of natural history; and have excited, during the last five or six years, more discussions in this room than have arisen out of any other part of secondary geology. Other antiquated errors, of like kind, have found a place of refuge in the pages of this "New System."



But let us pass over what may be, perhaps, only regarded as errors of omission, and see how the author has employed the materials before him. The best part of his narrative is made up of successive extracts, often taken word for word, yet without the marks of quotation, from various well-known works on geology. Many of these extracts, although in themselves admirable, appear in the book before us but as disjointed fragments, in the arrangement of which the author has but ill performed the humble duties of a compiler. For in the chapter on secondary formations, we find enormous faults and dislocations, of which there is neither any written record, nor any archetype in the book of Nature. Thus we find the lias sometimes below the oolites, sometimes between the oolites and the green-sand\*. In one page the cornbrash and forest marble have shifted places; in another the whole lower oolitic system is absolutely inverted†. Again, at p. 247, we are told that the several beds are given "as usual, in the ascending order;" yet in this very page the inferior members of the lower oolites are copied, word for word, from another book, and are in the descending order. On the next leaf, the same error is repeated in a still worse form: and within four pages of this last *bouleversement* we find the Oxford clay, the cornbrash, and the forest marble, twice shuffled under the great oolite‡. The goodly pile, Gentlemen, which many of you have helped to rear, after years of labour, has been pulled down and reconstructed: but with such unskilful hands that its inscriptions are turned upside down; its sculptured figures have their heads to the ground, and their heels to the heavens; and the whole fabric, amid the fantastic ornaments by which it is degraded, has lost all the beauty and the harmony of its old proportions.

So much has been written in illustration of the zoological history of our several formations, that the labour of a compiler is now made comparatively easy. Yet in the distribution of organic remains, given in the "New System," there is such a complication of errors as nearly baffles all attempts at description. In one place we are told, that the lower secondary rocks are characterized by the simplest forms of the animal kingdom. In another, we find fish enumerated among the fossils of the transition (or submedial) strata§. In one place our magnesian limestone is properly identified with the first flötz limestone of Werner. In another, our mountain limestone is placed on the same parallel; and, by a double blunder, is described "as the lowest sepulchre of vertebral animals||."

In one page orthoceratites are brought near the order of corals. In another, a coral is figured as an encrinite. In a third, the Steeple Ashton caryophyllia (the characteristic fossil of the middle oolite), is figured as a fossil of the inferior system. In a fourth, a caryo-

\* "New System of Geology." Compare pp. 133, 153 with pp. 137, 197.

† "New System," pp. 187, 195.

‡ *Ibid.* p. 253.

§ Compare Introduction, p. xlix. and p. 143.

|| "New System," pp. 175, 177, 187.

phyllia of the mountain limestone is figured among the organic remains of the cornbrash. And lastly, the celebrated lily encrinite (a characteristic fossil of the muschel-kalk, a formation unknown in England) is introduced and figured among the fossils of the lower oolitic system\*.

Errors like these are above every thing calculated to mislead men who are unpractised in geology; and they do not terminate here. But I have no right to detain you with a longer enumeration †. I have stated enough to prove, that in the conduct of this work, the author has shown neither the information nor the industry which might justify him in becoming an interpreter of the labours of others, or the framer of a system of his own.

\* See pp. 149, 176, 251, 256, 257.

† For the purpose of illustrating the organic remains "of the successive mineral strata," there are at the end of the "New System" five plates representing groups of fossils, with their generic and specific names. Had the figures been well selected, they might have been of great use: as it is, they can only be the means of disseminating error.

Plate I. professes to represent the "shells of the mountain limestone." Of its thirteen figures three or four are well chosen; none of the rest ought to have appeared. One of them is wrong named; and a recent nerita, with all its fresh markings, has unaccountably found its place among these old fossils.

Plate II. "Shells of the Lias." In this plate, of twelve species, we are astonished to find a transition orthoceratite, the productus scoticus of the mountain limestone, and a scaphite of the green-sand, placed, side by side, with the gryphæa incurva, plagiostoma gigas, and some other true lias fossils!

Plate III. "Shells of the under Oolite." Thirteen species; and a more uncharacteristic assemblage was, perhaps, never before brought together. A tertiary mya and a nummulite have here found their way, for the first time, among the shells of the under oolite. Two or three of the other species ought to have appeared, if at all, in the next plate.

Plate IV. "Shells of the Cornbrash and upper Oolites." Here the confusion is still greater; for of twelve species, seven are positively misplaced, the others are ill selected, and one of them is wrong named. The mineral conchologist is confounded at the sight of the well known turritiles and hamites of the green-sand group, of the turritellæ and superb rostellaria macroptera of the London clay, jostled in among the fossils of the oolites. Had the author drawn out by lot, from all the fossils in Mr. Sowerby's work, the species which were to decorate this plate, chance might have given him a more illustrative series.

Plate V. "Shells of the Chalk and Superior Strata." Among the nineteen figures of this plate, no attempt is made to separate the shells of the chalk from those of the overlying tertiary deposits; although the two groups have not perhaps one species in common. In Plate I. two freshwater shells were introduced which were not characteristic; here freshwater shells are characteristic, but are omitted altogether; and the pecten quinquecostatus is the characteristic fossil of the green-sand.

One who was even moderately acquainted with the characteristic forms of organic remains, could never have been led into such a complication of errors: and they are the more discreditable, as the greater part of them might have been avoided by the mere exercise of the humblest duty of a compiler.

Are we then for ever to wander among the mere perplexities of details, and never to hope for any system by which we may combine them? You must have seen, Gentlemen, that I am not the advocate of any such steril sentiment. It is indeed true that in the very classification of our facts and of our phænomena, there are difficulties connected with all parts of natural history, which, for ages yet to come, may continue to require for their solution a combination of the greatest industry with the greatest skill. But these difficulties do honour to our science: and the same great rule by which the father of physical astronomy was guided, applies, at every step, to us and to our conclusions. "*Effectuum naturalium ejusdem generis eadem sunt causæ*," was the grand rule of his induction. In the same way, we see the effects produced by the action of material things upon each other: and we know that the laws by which these material things are governed, are liable neither to change nor intermission. There is, therefore, one safe rule in all our inquiries, whether they be simple or complicated. Effects similar in kind to those which are produced now, must in all former times have been produced by some corresponding power of nature.

As the historians of the natural world, we can describe the order of the events which are past; and we can trace a succession of revolutions through which we go back, till we arrive at periods where the characters of nature's work are all obliterated, and there our descriptions end. Like things we can compare with like; and this comparison teaches us the analogies of the forms which we examine: but we define not the length of time during which they were elaborated; and still less do we dare to speculate about the physical revolutions of the ages which are to come.

The very commencement of the task of speculative geology requires a wide and philosophic knowledge of the physical world as it now is, and of all the great phænomena exhibited by the fragments of its former history. A mind so prepared has already within its grasp the means of a large induction: and our science, though hardly yet come out of its cradle, has supplied materials of thought for intellects the most robust, and results to satisfy imaginations the most ardent. Let us, therefore, go on as we have begun; giving up our best efforts to the search of new facts and of new phænomena, and using them like men who have no higher passion than the love of truth.

The greatest problems of astronomy are simple in their conditions. A few physical points moving in free space, with given velocities, in given directions, and acting upon each other in subordination to a given law,—these constitute the chief data for the mathematical analysis of the system of the heavens. And the results are of a corresponding simplicity. The phænomena of the heavens are demonstratively proved to recur in a fixed order, after the lapse of fixed periods of time; and the apparent aberrations from the general law are also proved to be but modifications of that law, and to return into themselves after the completion of definite secular periods. But where are the secular periods of geology, and where are its cycles of phænomena recurring, again

and again, in a certain order? I must confess that I cannot discover even the traces of them; and I think we do injustice to our subject, in bringing it too nearly into comparison with the exacter sciences.

The earth has been brought into its present form by countless causes of which we know nothing—by corpuscular and chemical action, varied by changes of temperature, of pressure, and of all other external conditions—by the violence of volcanic forces, called into being by unknown powers of nature, and at unknown intervals of time—by all the combined effects of mechanical degradation—and by all the endless modifications of matter, resulting from beings possessing the organs of life. These conditions are infinitely too complex and ill defined to come within the grasp of any exact analysis.

I believe therefore that our subject will never be so far abstracted from the materials which weigh it down, as to rise to the rank of an exact science. But this, at least, I will dare to predict; that so long as we are of one mind and animated by our present spirit, year after year, we shall find new fields for investigation, and new grounds for rational induction. That which is exact in science must be circumscribed and defined: but of our labours we have no power to foresee the limits; and there is an intense and poetic interest in the very uncertainty and boundlessness of our speculations.

It is no small advantage that our studies are so large and so various, that they not only carry us into all the kingdoms of nature, but have a direct bearing on the business of life. Of their economical importance, I have, however, now no time to speak; and I would rather conclude by reminding you of their importance in all questions of physical geography, to which they are as essential as anatomy to the sculptor, or the knowledge of ancient tongues to the decipherer of ancient monuments—of the light they have shed on every branch of natural history—and of the problems they have suggested to the investigations of exact science. Our field is indeed so large, and our physical problems of such complexity, that we find at every step, how much we stand in need of the support of our fellow-labourers; and this feeling has produced a strong social sympathy, not merely among us, but among the geologists of all the nations of Europe. It is to this principle that I am willing to attribute a part of the great excitement which has hitherto carried us on, and of those youthful and lusty efforts, which are the best indications both of our physical and of our moral health.

And now, Gentlemen, after having detained you so long, allow me to express my gratitude for the kind assistance which I have received from you in discharging all the duties of my office during the past year. Should your lives and mine be spared till another Anniversary, I hope to have the delightful task of recounting to you the still more extended labours of our body, and of rejoicing with you at the gathering in of a still richer harvest.

PROCEEDINGS  
OF  
THE GEOLOGICAL SOCIETY OF LONDON.

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1829-1830.

No. 16.

March 5.—Richard Smith, Esq. of Connaught Square; Sir Thomas Maryon Wilson, Bart. of Charlton House, Kent; Aristides Franklin Mornay, Esq. of Ashburton House, Putney; Rev. Counop Thirlwall, M.A. of Trinity College Cambridge; Rev. John Philip Higman, M.A. of Trinity College Cambridge, and William Parry Richards, Esq. of Queen Street, Bloomsbury,—were elected Fellows of this Society.

A paper was read, entitled “On the Tertiary deposits of Lower Styria;” by the Rev. Adam Sedgwick, Pres. G.S. F.R.S. &c. and Roderick Impey Murchison, Esq. Sec. G.S. F.R.S. &c.

The region described in this memoir is a great depression on the north-eastern watershed of the Alps, in which has been accumulated a very fine series of tertiary deposits, terminating eastward in the plains of Hungary. This great trough or bay of Lower Styria, which is intersected by the river Mur, is bounded on the west by the Schwanberg Alp; on the north by the calcareous chain of Grätz and the primary mountains of Pettau, Vöran, and Hartberg; on the south and south-west by the Matzels and Bacher-Gebirge.

Two principal sections are offered, explanatory of the views of the authors.—The first from the Schwanberg Alp to Radkersburg, in a direction nearly east and west, develops in an ascending succession all the tertiary deposits:—The second, from south to north, is confined to the youngest zone of those deposits, and exhibits its relations to the volcanic rocks of Hungary.

I. Section in an ascending order of the tertiary formations between Eibeswald on the west and Radkersburg on the east.

*a.* The lowest members of these deposits consist near Eibeswald, of micaceous sandstones, grits, and conglomerates, made up of the detritus of the primary slaty rocks on which they rest at high angles of inclination, and rise into the lofty mountain of the Radlberg.

*b.* Shale and sandstone with coal. There are various beds of lignite near Eibeswald, one of which is deposited on the grits of the Radlberg. At Scheineck, where the coal is extensively worked for use, it contains bones of anthracotheria, and in the shale are found gyrogonites (*Chara tuberculata* of the Isle of Wight), many flattened stems of arundinaceous plants, *Cypris*, shells of *Paludinæ*, scales of fish, &c. From the organic remains and position of the strata it is presumed by the authors that this coal is of about the same age as that of Cadibona in Piedmont.

c. Blue marly shale, sand, &c. The carboniferous strata are surmounted by dark-coloured marls inclosing well preserved shells, many of which are identical with species found in the London clay and Calcaire grossier, amongst which are *Lutraria oblata*, *Lucina mutabilis* and *L. renulata*, *Venus vetula*, *Cerithium thiara*, *Bulla cylindrica*, &c.

d. Conglomerate, with micaceo-calcareous sand and millstone conglomerate. This group is of very great development, and occupies all the hilly region of the Sausal.

e. Coralline limestone and marl. The preceding group is seen, both at Ehrenhausen and Wildon on the Mur, to pass under a hard, mottled, coralline limestone of a yellowish white colour, which at the latter place forms a cap several hundred feet thick in beds nearly horizontal. The fossils seem to be of the age of the English Crag and middle Sub-apennine formations, and include many corals of the genera *Astrea* and *Flustra*, Crustacea, *Balanus crassus*, *Conus Aldrovandi*, *Pecten infumatus*, *Pholas*, *Fistulana*, &c. The authors compare this coralline limestone with the tertiary marble of Possagno near Bassano, and they also observe that it far exceeds in magnitude the secondary coral rag of England.

f. White and blue marl, calcareous grit, white marlstone, and concretionary white limestone. The Mur in its easterly course from Ehrenhausen, exposes all the members of this and the following group, although some of them are still better seen in transverse sections to the south. At Santa Egida, concretionary white limestone, alternating with marls, contains *Pecten pleuronectes*, *Ostræa bellocicina*, *Scaligeria*, *Cypræa*, &c. and in the Zirknitz-thal, *Echinanthus marginatus* with gigantic oysters and pectens. At St. Kunegund and Morggruben the white marls graduate into a compact building-stone undistinguishable from the clunch or lowest chalk of Cambridgeshire. Near Mureck on the right bank of the Mur, the upper portion of this group is remarkable by containing a very white concretionary limestone, made up of small tubular and concentric layers, several varieties of which, occurring in other parts of this tertiary series, very much resemble concretions in the magnesian limestone of England.

g. Calcareous sands and pebble beds, calcareous grits and oolitic limestone. These form the superior and youngest stratified deposits of the country. At Radkersburg, where the section terminates and the hills sink into the plains of Hungary, the sands, marls, and grits are charged with shells, some of which are identical with existing\* species, the whole group being similar to those of the highest members of the basin of Vienna. Other beds pass into concretionary masses of an oolitic limestone, similar to that which is described in the next section.

The second section from Radkersburg on the south to Riegersberg on the north, exhibits the structure of the youngest zone of the tertiary deposits of Styria, and its relations to certain volcanic rocks.

Several lofty and serrated ridges of volcanic rocks range from Hain-

\* *Mactra carinata* and *Cerithium vulgatum*.

feldt on the Raab towards Radkersburg, and a section made along their western face offers the following phenomena.

At Straden, shelly sands and pebble beds are capped by irregularly columnar basaltic lava with olivine, &c.

The hill of Poppendorf exhibits in great detail the structure of this younger tertiary zone. Marls, sands, and conglomerates, occupy its lower and middle parts, together with many beds of calcareous, shelly grits, indurated marlstone, limestone, &c. the whole being very micaceous, and the organic remains identical with those of Radkersburg. These are overlaid by micaceo-calcareous sand, containing concretionary masses of a perfect oolite which is quarried as a building stone, and which differs from the great oolite of Bath only by its concretionary structure and the tertiary shells associated with it.

The fine-grained oolite passes upwards into other concretionary beds something like English cornbrash, and the whole is surmounted by micaceous sands and marls. In an adjoining hill near Gnaess, these beds inclosing shells alternate with volcanic peperino made up of basaltic lava, scoria, vitreous felspar, olivine, pyroxene, the detritus of tertiary rocks and shells, &c.; and on the summit the peperino in a more compact state is quarried as a building-stone. The conical hills of Gleichenberg, overlying the shelly sands, are entirely of volcanic origin, and were probably the centre of igneous eruption in these parts. Here the predominating rock is a coarse trachyte used for millstones (felspathic porphyry, probably analogous to the *Porphyre molaire* of Beudant), and with it are associated basaltic lavas, scoria, and fine peperino, which near Hainfeldt repose upon the sands. Considerably to the north of the Raab the volcanic conglomerate on which the castle stands is also recumbent upon the shelly sands and pebble beds.

From these and several other examples in the neighbourhood, the authors infer, that no tests can be established by which the relative ages of these various igneous rocks can be fixed, since the same tertiary strata are in one place covered by basaltic lava, in a second by trachyte, in a third by volcanic conglomerate, whilst in a fourth they alternate with peperino.

In conclusion they remark :—

That the lowest tertiary strata near Eibeswald must from their high inclination have been considerably elevated after their deposition.

That the various groups described, unquestionably represent,—1st, the Paleotherian and Calcaire grossier period :—2ndly, The Crag and middle Sub-Apennine formations :—3rdly, Newer deposits identical with those of the adjoining bay of Vienna, which is shown to have been connected with the bay of Grätz by the intervention of the great tertiary sea which once occupied all the plains of Hungary.

That the volcanic forces in this region were first called into action during the most recent of these periods, and were probably continued in activity through the long succession of ages in which the sea was spread over these countries.

Lastly, That the volcanic rocks stand out in such prominent masses, as to offer emphatic proofs of the enormous degradation and waste

of the surface of the country, since the formation of some of the newest regular strata known in geology.

March 19th.—Henry Rowland Brandreth, Esq. of the Royal Engineers, Woolwich; Sir Thomas Phillips, Bart. of Middle Hill, Worcestershire; and Robert Alfred Cloyne Austen, Esq. of Lincoln's Inn,—were elected Fellows of this Society.

Extracts were read from a paper entitled "Reference to a Geological Map and Section of Pembrokeshire," by Alfred Thomas, Esq., Mineral Surveyor, Haverfordwest.

The author accompanies the map and section with geological and economical remarks. The map comprehends all that northern part of Pembrokeshire not described by Mr. De la Beche, and the section is drawn from St. Gowan's Head on the south to Cardigan on the north. The alternations of the different formations in the county are detailed in a series of descriptive sections: the chief masses are coal measures, including culm and coal grits, mountain limestone, old red sandstone and conglomerate, transition limestone, grauwacke, grauwacke slate. All these, in the central and southern parts of the county, are traversed by, or alternate with trap rocks which are of various kinds, some being syenitic, others hornblendic and amygdaloidal, whilst near Fishguard they are columnar and basaltic. The beds of the stratified deposits are frequently contorted, and their nature altered in contact with the intrusive rocks. The transition limestone contains trilobites.

The first of two letters addressed to R. I. Murchison, Esq., Sec. G.S. F.R.S. &c. "On the Lacustrine Basins of Baza and Alhama in the province of Granada, and similar deposits in other parts of Spain," by Col. Charles Silvertop, F.G.S., was then read.

The Sierra Nevada, rising to the height of 11,000 and 12,000 feet above the sea, is the culminating point of a number of subordinate mountain groups which form a lofty chain stretching from Andalusia on the W.S.W. to Murcia on the E.N.E. and bisecting in its range the kingdom of Granada.

This chain is composed of a central axis of gneiss and mica schist, with successively overlying zones on each flank of transition and secondary rocks, which on the south and along the shores of the Mediterranean are here and there covered with patches of tertiary marine deposits containing Sub-Apennine shells; whilst on the northern flank of the chain, or towards the interior of Spain, the secondary rocks are succeeded by formations of lacustrine origin, which in the kingdom of Granada occupy two large and separate basins, one near Baza, the other near Alhama. These great and elevated depressions in the secondary rocks, though at little distances from the Mediterranean, are so cut off from that sea by the Sierra Nevada, that their drainage is effected in a north-westerly direction into the Guadalquivir, and thence into the more distant Atlantic. The author describes in detail the basin of Baza, which, traversed by an insignificant stream called the Rio Baza, is surrounded upon three of its sides by a secondary nummulite-limestone; the precise age of which he does not pretend to determine, although



he states that it very much resembles certain varieties of the younger Alpine limestone.

Unconformably deposited on this and other older rocks, within a district the average diameter of which is about thirty-five miles, there are spread out formations of considerable thickness, the organic remains of which are exclusively lacustrine and tertiary. These in the immediate neighbourhood of Baza are divided into two principal groups; the lowest, consisting of marls with laminated gypsum, sulphur and brine springs, is zoologically distinguished by the presence of *Cypris*; the uppermost is a compact, cream-coloured limestone, charged with many small *Paludina* of a species identical with one which is found in the lacustrine formations of Central France. The united thickness of these fresh-water groups in the neighbourhood of Baza cannot be estimated at less than 300 and 400 feet; they are generally horizontal, but the face of the country everywhere exhibits striking proofs of immense degradation, the gypsiferous marls being denuded throughout the greater part of the centre of the basin, and but rarely exhibiting caps of the compact *paludina*-limestone. On the southern, eastern, and south-western flanks of the basin, particularly near Gaudix, there are vast accumulations of pebble beds, conglomerate, &c., the exact relations of which to the marls and limestone the author could not satisfactorily determine, owing to the obscurity of the sections; although he is of opinion that there are conglomerates which in some places pass under the marls, whilst in others they are decidedly overlying.

The reading of the letter on the Basin of Alhama was deferred until another evening.

April 2nd.—William Hallows Miller, Esq., M.A., of St. John's College, Cambridge; Lloyd Baker, jun., Esq., of Hardwick, Gloucestershire; William Granville Eliot, Esq., Lieut.-Col. of the Royal Artillery, Hastings; Rev. Henry Engleheart, of Caius College Cambridge, and Seal, Kent; Josias Lambert, Esq., of Liverpool Street, London; and Thomas Morgan, Esq., of Thames Ditton, Middlesex,—were elected Fellows of this Society.

The reading of a paper on the Geology of Weymouth, and the adjacent parts of the coast of Dorsetshire, by the Rev. William Buckland, D.D., F.G.S., F.R.S. &c., and Henry Thomas De la Beche, Esq., F.G.S., F.R.S. &c., was begun.

April 16th.—John Rennie, Esq., of 15, Whitehall Place; George Rennie, Esq., of 21, Whitehall Place; Alfred Thomas, Esq., of Haverfordwest, Pembrokeshire; Charles Mundy, jun., Esq., of Burton Hall, Loughborough; and Alexander Turnbull Christie, M.D., of the East India Medical Service,—were elected Fellows of this Society.

The reading of a paper on the Geology of Weymouth, and the adjacent parts of the coast of Dorsetshire, by the Rev. Dr. Buckland, and Henry Thomas De la Beche, Esq., begun at the last Meeting, was concluded.

The authors take up the history of the geology of the coast of Dorset at the point where Mr. Webster terminates, viz. at the chalky promontory of White Nore, about eight miles E.N.E. of Weymouth, and continue their account of the coast thence westwards to the lias at Charmouth. The Memoir is accompanied by a map and many sections both of the cliffs and of the adjacent inland district, including the space intermediate between the escarpment of the chalk downs of Dorsetshire and the sea. The authors divide this district into two compartments, viz. the Vale of Weymouth and the Vale of Bredy.

The structure of the Vale of Bredy is comparatively simple, being chiefly composed of chalk, greensand, Kimmeridge clay, Oxford oolite, forest marble, and inferior oolite, dipping for the most part to the E. and N.E. and divided by thick beds of clay.

The Valley of Weymouth is more complicated, comprehending tertiary strata, chalk, greensand, Purbeck and Portland beds, Kimmeridge sand and clay, Oxford oolite, Oxford clay, cornbrash and forest marble. To the forest marble belong the lowest strata that form the axis of this district. Nearly all these strata are highly inclined, and dip respectively in two opposite directions from an anticlinal line which runs through a saddle of forest marble from E. to W.

The uppermost of these strata on the N. side constitute the chalk escarpment of the ridgeway, capped with patches of plastic clay; whilst on the S. no strata appear above the sea more recent than those which form the Isle of Portland.

Between the ridgeway-chalk-escarpment and the Isle of Portland, the strata are disposed in a succession of long and narrow belts of clay and stone, the clay constituting valleys, and the stone rising into ridges between the valleys; all these belts are terminated eastward by the bay of Weymouth, and westward by the Chesil Bank.

The formations composing this district are described in the following order.

1. Plastic clay and sands, with blocks of puddingstone, and beds of angular flints forming a breccia in place, occur on the surface of the chalk.
2. Chalk presenting no remarkable peculiarities.
3. Greensand formation exhibiting no distinct traces of gault. The Wealden formation terminates a little W. of Lulworth Cove.
4. Purbeck beds appearing in two long insulated patches at Osington and Upway.
5. Portland stone occurring not only throughout the island of that name, but forming a high and narrow ridge parallel and immediately subjacent to the escarpment of the chalk along nearly the whole north frontier of the Vale of Weymouth.
6. Between the Purbeck and Portland formations there is a very remarkable bed of black earth called the "Dirt Bed," already described by Mr. Webster as being mixed with slightly rolled pebbles of Portland stone\*, and containing, in a silicified state, long pros-

\* Geol. Trans., Second Series, vol. ii. p. 42.

trate trunks of coniferous trees and stems of Cycadeoidæ. These trunks lie, partly sunk into the black earth, like fallen trees on the surface of a peat bog, and partly covered by the incumbent limestone. Many stumps of trees also remain erect, with their roots attached to the black soil in which they grew, and their upper part in the limestone; and show that the surface of the subjacent Portland stone was for some time dry land, and covered with a forest, and probably in a climate such as admits the growth of the modern *Zamia* and *Cycas*. This forest has been submerged; first beneath the fresh waters of a lake or estuary, in which were deposited the Purbeck beds and sands and clays of the Wealden formation, (amounting together to nearly 1000 feet), and subsequently beneath the salt water of an ocean of sufficient depth to accumulate all the great marine formations of greensand and chalk.

7. Below the Portland stone, and dividing it from the Kimmeridge clay, the authors establish a deposit, hitherto unnoticed, of sand and sandstone 80 feet thick, which they call the Kimmeridge sandstone; it is full of grains of green earth, and scarcely distinguishable, except by its fossils, from the greensands immediately below the chalk: they also have ascertained that the pseudo-volcano still burning on the north of Weymouth is in the bituminous beds of the Kimmeridge clay, and that there has been at some unknown former period a similar combustion of the same clay on the shore near Portland ferry.

8. The Oxford oolite is very fully developed near Weymouth, as it is near Scarborough, passing into beds of sand, sandstone, and clay at its upper and lower extremities; containing *Ostrea deltoidea* in the upper, and *Gryphæa dilatata* in the lower beds; and gradually passing into Kimmeridge clay above, and into Oxford clay below: its thickness exceeds 150 feet. The history and character of this oolite formation at Weymouth have been fully described in all their details, and accompanied by a valuable list of its fossils, in a paper on the strata of the Yorkshire coast, by Professor Sedgwick; *Ann. Phil.*, May 1826.

9. The Oxford clay is about 300 feet thick, and contains large septaria, which are cut into beautiful tables, under the name of Turtle Marble. This clay abounds throughout with shells of *Gryphæa dilatata*.

10. The cornbrash and forest marble form the axis of the Valley of Weymouth, and occupy much of the Valley of Bredy. The forest marble formation abounds in beds of clay, and is often composed of clay without the marble. The Bradford Encrinite (*Apicrinites rotundus*) is found in several parts of it, e. g. at Abbotsbury, at Bothenhampton, and in the cliff west of Bridport Harbour.

11. There is no Bath oolite stone in Dorsetshire, but the inferior oolite occupies a large extent near Bridport, affording coarse limestone like that of Dundry in its upper, and micaceous sand with beds and concretions of calcareous sandstone in its lower part. Its total thickness is about 300 feet. Near its middle region are masses of breccia, containing slightly rolled fragments of the lower strata,

and having the entire circumference of these fragments drilled all over by some small lithodomous shells; these fragments attest the consolidation of the lower strata before the deposition of the central beds, and mark an interval in the formation sufficient for the fragments to have been rounded and perforated.

12. The lowest strata, within the district described, are the upper marl beds of the lias formation on the east of Charmouth; these are loaded with belemnites, and may represent the *Calcaire à Belemnite* of the French geologists; as the lower stony beds of lias at Lyme are equivalent to their *Calcaire à Gryphite*. On the shore east of Charmouth the marl beds present an almost continuous pavement of belemnites, and also contain saurians.

13. The elevation which has raised all the component formations of the Valley of Weymouth towards an anticlinal axis, has been accompanied by extensive faults, the most remarkable of which are parallel to the anticlinal axis, and appear to have been contemporaneous with the general elevation of the district. One of these faults is continuous nearly 15 miles along the escarpment of the chalk of the ridgeway, on the north of Weymouth, and at various places brings up strata of oolite, Portland stone, and Purbeck stone into contact with chalk and greensand; many sections are given illustrating the effects of these faults, not one of which appears to be anterior to the deposition of the most recent strata in the district.

14. Subsequently to, or perhaps contemporaneously with the elevation of the strata and production of the faults, the surface has been ravaged by a tremendous inundation which has swept away all the ruins and rubbish of the elevated masses, and has excavated valleys of many hundred feet in depth on the surface of the strata that remain. Outlying summits, composed of residuary portions of strata which are continuous along the escarpments on the north and east of the Vale of Bredy, indicate the original continuity of these strata over large portions of that district, from which they have been removed.

15. Small deposits of diluvium are scattered over many of the hills as well as the valleys, but there are no very thick and connected accumulations of gravel; the force of the water that could produce such enormous excavations must have been far too great to allow the excavated materials to subside so near the rocks from which they were torn, and must have drifted them far away into the continuation of these valleys, in the bottom of the English Channel.

The authors conclude that they have sufficient evidence to establish the following succession of changes, in the state of that small portion of England which occupies the coast of Dorsetshire and Hants.

1st. There is a continuous succession of marine deposits from the lias upwards through the oolites, terminating in the deposition of the Portland stone:—during the period of all these formations the district must have been the bottom of an ancient sea.

2ndly. Some part of the bottom of this sea appears for a certain time to have become dry land, and whilst in that state, to have been covered with a forest of large coniferous trees and cycadeoidous plants which indicate a warm climate. We have a measure of the duration of this forest in the black earth which is accumulated to the thickness of more than a foot from the wreck of its vegetation: the regular and uniform preservation of this thin bed of black earth over a distance of many miles, shows that the change to the next state of things was not accompanied by any violent denudation or rush of waters, since the trees that lie prostrate on this black earth would have been swept away by any such violent catastrophe. Dr. Buckland has found this same black earth on the surface of the Portland stone near Thame in Oxfordshire. It has also been found by Dr. Fitton in the Boulonnois.

3rdly. The dry land on which this forest grew, in Dorsetshire, became converted to something like an estuary, in which the lowest deposits contain freshwater shells, succeeded by a thick bed of oyster shells; and above the oyster bed, by strata containing an admixture of freshwater shells with shells that are marine. This freshwater formation, including both the Purbeck and the Wealden strata, extends with certain interruptions from Upway on the N. of Weymouth to the E. extremity of Purbeck, and reappears in the Isle of Wight and the Weald of Sussex and Kent; but of the boundaries of the estuary or estuaries in which these freshwater strata were deposited we have no indications beyond those afforded by the area of the strata themselves. Its breadth probably extended about 30 miles from Purbeck to Tisbury on the west of Salisbury, across the intermediate portion of Dorset and Wilts, which is now covered up with chalk.

4thly. We have a return of the sea over the estuary, and in this sea an accumulation of the successive and thick marine deposits which constitute the greensand and chalk formations.

5thly. Although no freshwater formations occur in the tertiary strata above the chalk on the coast of Dorset, we have on the adjacent coast of Hants and the Isle of Wight, a re-appearance of freshwater deposits above the chalk, mixed and alternating with others that are marine.

6thly. All these deposits appear to have been succeeded by powerful convulsions, producing elevation and depression of the strata, intersecting them with tremendous faults, and followed by an inundation competent to excavate deep valleys of denudation, and to overspread the country with diluvial gravel.

7thly. This inundation has been succeeded by a state of tranquillity, which has continued to the present hour.

A paper entitled "Description of a New Species of *Ichthyosaurus*," by Daniel Sharpe, Esq., F.G.S., was then read.

This specimen of *Ichthyosaurus* was found in a quarry of lias limestone about four miles from Stratford-upon-Avon. The whole length of the animal must probably have been about seven feet; the parts

of it which remain exhibit the upper portion of the head from the nostrils backwards, in a very crushed state, a continuous series of 52 vertebrae, from the atlas to the commencement of the tail, with nearly all the spinous processes; one scapula, and nearly the whole of one fore paddle. The teeth (by which the four species formerly described have been chiefly distinguished) are entirely wanting in this individual; the author, however, considers it to be a new species, from the following peculiarities of character.

1. The length of each vertebra is uniformly three-fifths of its breadth, a proportion not found to exist in any hitherto described species.

2. The paddle is of great size, and including the humerus must have been equal to one-fifth of the length of the whole animal. In the ulna or radius (it is difficult to say which) there is a notch on the outer edge, and all the other bones of the paddle are very nearly circular or oval; thus differing essentially from the angular-shaped phalanges of *I. communis*, *tenuirostris*, and *intermedius*.

On account of the large size of its paddle, the author names this species "*Ichthyosaurus grandipes*."

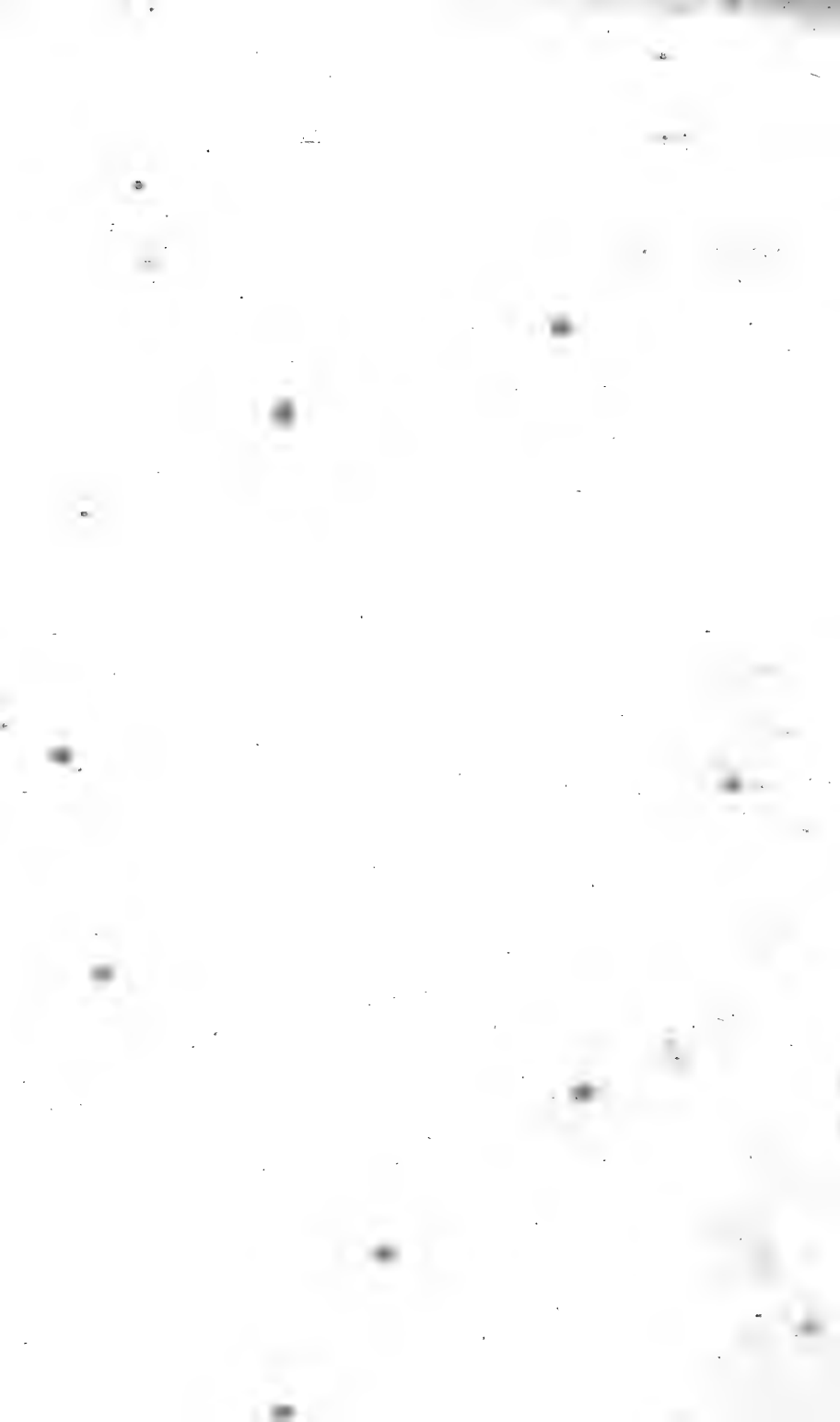
The Report having been read, it was resolved,—

1st. That this Report be received.

2ndly. That the thanks of this Society be given to the Rev. W. Buckland, D.D., and George Bellas Greenough, Esq., retiring from the Office of Vice-Presidents.

3rdly That the thanks of this Society be given to William John Broderip, Esq., retiring from the Office of Secretary.

4thly. That the thanks of this Society be given to James Ebenezer Bicheno, Esq., John Bostock, M. D., Decimus Burton, Esq., Captain George Everest, Michael Faraday, Esq., William Henry Fitton, M.D. and the Rev. James Yates, retiring from the Council.





PROCEEDINGS  
OF  
THE GEOLOGICAL SOCIETY OF LONDON.

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1830.

No. 17.

May 7.—Thomas England, Esq. B.A. of Pembroke College, Cambridge; Howard Elphinstone, Esq. M.A. of Trinity College, Cambridge; and Robert Edmond Grant, M.D. F.R.S. Ed. Professor of Comparative Anatomy and Zoology in the University of London,—were elected Fellows of this Society.

A Paper was read, entitled “Sketches explanatory of Geological Maps of the Archduchy of Austria and of the South of Bavaria;” by Ami Boué, M.D. For. Mem. G.S. &c.

The accompanying maps of the Archduchy of Austria and of Bavaria were made during repeated visits to those countries, and partly with the assistance of M. Partsch of Vienna.

The author premises that in consequence of his last visit, in 1829, he has changed some classifications, and rectified certain errors which appear in his former works.

I. *Structure of the Archduchy of Austria.*—Dr. Boué describes the principal part of Austria as consisting of the primary chain of Southern Bohemia on the north, and of the great secondary calcareous Alpine chain on the south, which are separated from each other by the tertiary and alluvial valley of the Danube. He divides this last region into three parts:—

1. The molasse and alluvial basin of Upper Austria, extending from Bavaria to near Blindenmarkt and St. Leonhard.

2. The basin of St. Polten, containing shelly sand, sandstone, marl, alluvial marl, and gravel.

3. The basin of Vienna, which is now united with that of St. Polten by a narrow gorge of the Danube.

The direction of the primary chain of Bohemia is from south-west to north-east; gneiss being the predominant rock, with some subordinate masses of granular limestone and diorite. Granite occurs in the western, and sienite, leptinite, and serpentine in the eastern part of this range. The central ridges of the Alps are primary, and these are succeeded, in an ascending order, by talco-quartzose rocks, distinguished by masses of compact limestone with iron ore. Between the preceding rocks and the escarpments of the Alpine limestone, are ancient longitudinal valleys, which certain rivers occupy in their early course, and afterwards quitting abruptly, run at right angles through newer and transverse rents in the secondary formations. At the base of the Alpine limestone, and subordinate to it, are red sandstone and shale, with gypsum, but without porphyry. This group can be traced from Mont Blanc to Hungary, and it again appears.

in the Tatra, or northern Carpathians. The Alpine limestone is characterized generally by organic remains common to the superior secondary formations, such as Belemnites, Ammonites, Nautili, Echini, and many zoophytes; but accurate subdivisions of it are made with great difficulty.

One of the most important of these subdivisions is marked by the presence of salt and gypsum, which are found in shale, associated with gray sandstone and limestone, containing Belemnites, Ammonites and Fuci; and in some places, as at Hallein, with orthoceratite and madreporic limestone.

Dolomite prevails in the upper part of the Alpine limestone, and is usually connected with peculiar anomalies of stratification and inclination, which according to the author offer evidence of the rupture and friction of the displaced masses; the whole having, he conceives, been elevated and depressed by the action of subterranean gaseous forces.

Another member of the Alpine limestone is characterized by lead and iron ores.

The Alpine limestone passes into a superior sandstone (designated as "Vienna sandstone"), with alternations of marl and schistose, lithographic limestone and whetstones. This part of the series contains coal at Greater Ipsitz, &c. with Cycadeæ; and in other places this group is capped by ruiniform, compact limestone, with Ammonites, Belemnites, and Fucoides. (St. Veit, Sontagsberg, Elixhausen, &c.)

Serpentine and greenstone traverse secondary sandstone at Ipsitz, and both sandstone and Alpine limestone at Willendorff.

The author then proceeds to identify certain rocks having a similar mineralogical character, whether in the northern Carpathians, where they rest upon the "Vienna sandstone", or at Grünbach near Vienna, where they are stated to contain Belemnites and Ananchytes ovata, with the formations of Gosau-thal, which Messrs. Sedgwick and Murchison, he states, have erroneously described as tertiary. He does not admit that this deposit of Gosau can be considered as intermediary between the secondary and tertiary formations, but he assigns to it the place of the lowest secondary green-sand.

The tertiary character of many of the remains is not considered by him to prove the age of this deposit, for he states that some fossils in the oldest secondary rocks at Halle, Bleiberg, and Maibel in Carinthia, have also a tertiary appearance.

The true green-sand of the Alps is then described; and the author identifies the iron ores of Sonthofen with those of the Kressenberg, which Count Munster, as well as Messrs. Sedgwick and Murchison, has considered tertiary\*.

Chalk is stated not to exist in the German Alps, though the lower green-sand of Gosau contains beds like the *Planer Kalk* or upper green-sand. The tertiary deposits of Austria are stated to belong entirely

\* In this part of the paper Dr. Boué has been led into an error in consequence of misunderstanding a passage in the abstract of a communication by Messrs. Sedgwick and Murchison, published in the Phil. Mag. and Annals for January 1830, p. 53. The deposit of Sonthofen was never considered tertiary: but on the contrary, was distinctly stated by them to be secondary.

to the superior division of that great class of rocks, and the author asserts that they in no case enter into the Alpine regions, except on the eastern side, viz. in the drainage of the Mur, the Scive, and the Drave, where they occupy ancient longitudinal valleys.

Häring, described by Messrs. Sedgwick and Murchison as an ancient estuary, or area of the great tertiary sea of Bavaria, is considered by the author to be a continental, local, freshwater formation.

The lowest tertiary formations of Austria are, he says, characterized by blue, shelly marl, and marly, shelly molasse (*Schlier*), which he assimilates to sub-apennine marl.

In lower Austria this blue marl is succeeded by sands, marls, lignite, and shells, both marine and fluviatile, and these again by gravel and conglomerate, and lastly by nummulite and coralline limestone, alternating with sands and conglomerates, which separate the true tertiary basins of Vienna and Hungary from the deposits of the alluvial period.

The oldest alluvial gravel follows many Alpine valleys in the form of terraces, and the same is extended with beds of marl far into the actual valleys of the Danube and the March, and also into the plains of Hungary, where bones of extinct quadrupeds and terrestrial shells are found in it.

It is in the marl of this old alluvium near Krems that the human skulls have been found, which have been described by Count Breunner. The author remarks on the peculiar form of these skulls, and their resemblance to those of the Caribs and Chilians, &c.; also that he has himself found human skulls in alluvial marl of the same age at Lahr in the valley of the Rhine.

II. *Structure of the south of Bavaria.*—The south of Bavaria is chiefly occupied by an extensive tertiary basin, from 1600 to 2000 feet above the level of the sea, which is bounded by the primary range of Bohemia and the German Jura on the north, and by the Alpine chain on the south; whilst it communicates with the tertiary deposits of Vienna and Hungary by the valley of the Danube, and with the molasse of Switzerland on the west.

The German Jura offers no fissures or transverse valleys by which this basin of Bavaria could have communicated with the Neckar and the Maine; and at the period of the tertiary deposits this great depression must have been equally shut out from all communication with the Mediterranean, by the intervention of the Alpine chain, which the author, differing from M. Von Buch, has in former memoirs demonstrated to have been elevated at various periods; an idea which has subsequently been adopted and enlarged upon by M. Elie de Beaumont.

The German Jura contains also the subdivisions of the oolitic series, from lias up to Stonesfield slate and cornbrash, viz.—1. Lias without the white beds. 2. Lias marl. 3. Lias sandstone. 4. Inferior oolite, with iron ores. 5. Great oolite, mostly compact. 6. Dolo-mitic limestone. 7. Calcareous slate of Solenhofen, with tortoises, fishes, crustacea, Sepiæ, Ammonites, Belemnites, Lepadites, insects, and vegetables.

Upon this system of Jura limestone there are small patches of iron and green-sand at Ratisbon and elsewhere. In this deposit, associated with argillaceous marl, are found the pisiform iron ores, or Bohnerz of the Germans; concretionary masses of siliceo-calcareous millstone, with many univalve shells and corals (Natheim); and beautifully zoned, chalcedonic nodules, or *kugel jaspis*, with Echini and microscopic shells (near Basel).

The author agrees with Mr. Schübler that it is essential to distinguish this deposit of Bohnerz from those alluvial accumulations with iron ore made up of the detritus of older rocks, and in which are found the bones of many extinct quadrupeds. (Kandern, Haiberg near Tuttingen, &c.)

The Alpine chain south of the tertiary basin of Bavaria is constituted of materials nearly the same as in its range through Austria; viz. 1. A base of red-sandstone and conglomerate. 2. Lower limestone with fishes (Seefeld). 3. Gray sandstone and shale with salt and gypsum. 4. Gray dolomite and oolite. 5. Sandstone of Vienna, which though thin and obscure at Salzburg and Sonthofen, expands into a vast formation in its westward range into the Voralberg. 6. Green-sand, filling cavities in the Vienna sandstone, from which it is separated by conglomerates made up partly of Alpine limestone, but chiefly of primary rocks, which are not found *in situ* nearer than the Black Forest. The author conceives this conglomerate to be of the same age as those at the base of the Gosau formations, and in the Allgau; and he further identifies with it the *Nagelflüh* of Switzerland, which, although hitherto considered tertiary, he places in the lower green-sand; and as proofs of this he cites the existence of a similar conglomerate or *Nagelflüh* on the summit of the Voisons near Geneva, and also near Saanen, where it overlies and is united with what he considers to be the equivalent of the Vienna sandstone.

The green-sand of the Allgau consists of marls and calcareous sands of various colours containing plants, with here and there subordinate masses of true green-sand, having some characteristic fossil shells of that formation, and iron ore.

For the details of the tertiary rocks of Bavaria the author refers to his last work (*Geognostisches Gemälde von Deutschland*). In speaking of the vast alluvial accumulations which encumber this basin, he remarks that the debris are all primary near the primary chain of Bohemia, and secondary on the flanks of the Alps or Jura. Erratic boulders of large size are spread out in lines, and extend to some distance in front of the mouth of the valley of the Rhine; whilst lesser detritus only is found at the *debouchure* of the Inn. According to the author, the elevatory forces which so greatly affected the western Alps, must have operated less powerfully upon the eastern prolongation of these mountains.

Alluvial marl, as in Austria, covers the sides of the Danube in its course through Bavaria; and all the lower regions of the latter country offer innumerable proofs of various changes during the alluvial period in the successive drainage of lakes, and in the alteration of the course of rivers.

May 21.—Grenville Lonsdale, Esq. Ensign in the Third Foot, was elected a Fellow of this Society.

A Paper was read, entitled "A Sketch of the Structure of the Austrian Alps;" by the Rev. Adam Sedgwick, Pres. G.S. F.R.S. Woodwardian Professor in the University of Cambridge, &c., and Roderick Impey Murchison, Esq. Sec. G.S. F.R.S. &c. &c.

The authors, after briefly noticing some of the memoirs which have been written in explanation of the geological structure of the Alps, proceed to exhibit the results of their own observations, made in the summer of 1829, during several traverses among the eastern parts of the chain. They state that the structure of the eastern Alps, when considered only in a general point of view, is of great simplicity; the chain being composed of an axis of primary and transition rocks, chiefly of a slaty texture; flanked and surmounted by two great secondary calcareous zones, which are in their turn surmounted by tertiary deposits, descending on one side into the plains of Italy, and on the other side into the elevated plains of the Upper Danube. They then notice the extraordinary derangements in the position of some of the great mineral masses of the Alps; and afterwards describe in considerable detail a section from the plains of the Friuli to the valley of the Traun near Salzburg over the metalliferous hills of Bleiberg, and over the crests of the Katsberg and Tauern Alp. They also describe a second section parallel to the former, from the primary mountains of Gastein, through the saliferous deposits of Hallein and the hippurite-limestone of Untersberg to the tertiary plains of Bavaria.

The formations appearing in the lines of these two sections are the following, in ascending order:—

1. *Primary rocks forming the central axis.*—The range of the primary peaks, eastwards from the confines of the Tyrol, is described. It is remarked that as the chain decreases in elevation in its range eastward, the prevailing character of granitoid gneiss gives way to that of mica schist; it is then stated that in both the sections these rocks pass into the next superior system through the intervention of chloritic schist with subordinate beds of crystalline, white limestone.

2. *Crystalline rocks containing calcareous beds, with traces of organic remains and graduating into other rocks conforming to the ordinary transition type.*—This series contains many beds not to be distinguished from the former class; but it appears to be characterized by a greater quantity of limestone, many parts of which are perfectly crystalline. At the southern base of the Tauern the authors discovered mica-slate with garnets, and chlorite-slate containing thin layers of white dolomite, alternating with thicker beds of a dark blue colour, containing many encrinital stems. The whole system is described as passing into a series of calcareous peaks, some of which rise to the height of nearly 9000 feet above the level of the sea. The whole series is considered to terminate with a system of beds, composed of variously coloured shales, passing into grauwacke-slate, alternating with greenish-gray and reddish fine-grained grauwacke-sandstone, subordinate to which are beds of highly calcareous slate and limestone, and masses of sparry iron ore. The authors give some details respecting the chief

localities of the sparry iron ore, and they place the principal deposits of the mineral on the confines of the secondary system.

In confirmation of their views they describe sections on the south side of the central axis, especially in the neighbourhood of Bleiberg, where they state that the secondary system is immediately underlaid by grauwacke-slate, containing calcareous beds with many organic remains, chiefly composed of encrinital stems and shells of the following genera, viz. *Producta*, *Terebratula* and *Pecten*. Two or three of these shells have been identified with species characterizing the English mountain limestone. They therefore conclude from the evidence of organic remains, as well as from mineralogical characters, that in this part of the eastern Alps there is a zone of true transition rocks, interposed between the primary and the secondary series.

3. *Red and variegated sandstone, gypseous marls, and conglomerates; sometimes with subordinate beds and masses of fetid limestone, rauchwacke, &c. &c.*—It is stated that this formation is found nearly through the whole extent of the Austrian Alps, overlying the transition series, and forming the base of the precipices of older Alpine limestone. A detailed section, south of Werfen, exposes beds of red conglomerate, sandstone, and red gypseous marls, not to be distinguished mineralogically from the new red sandstone of England. Other sections in the valley of Bleiberg in Carinthia, and on the north side of the Erzberg, exhibit similar deposits of red sandstone and gypseous marls, separating the grauwacke, with the organic remains abovementioned, from the Alpine limestone; they are accompanied by great dislocations, and the appearance of masses of dark-coloured augitic trap and of trap breccia. Subordinate to the red sandstone series between Haring, Söll and Schwatz, are many masses of limestone of very varied structure. Some of them are compact, some white and crystalline, some yellow and earthy, and some cavernous. The greatest number of them are magnesian, and some of them bituminous and fetid. These masses of limestone were formerly considered as transition. As, however, these different varieties of limestone appear to be subordinate to the red sandstone, they are placed by the authors in the secondary system, and are compared with the beds of magnesian limestone, which in so many parts of Europe are subordinate to the great group of the new red sandstone.

The rocks above described are immediately surmounted by the Alpine limestone, under which term are included the two great secondary calcareous zones of the Alps overlying the red sandstone groups. This enormous deposit is subdivided into older Alpine limestone, limestone with subordinate saliferous marls, &c., and younger Alpine limestone.

4. *Older Alpine limestone.*—Near Bleiberg the red sandstone group is surmounted by a thinly bedded fetid limestone, which forms the base of, and appears to pass into the lower portion of the older Alpine limestone. A detailed section of the beds forming the base of the northern calcareous zone near Werfen, brings the two zones under comparison. It is shown that the thin-bedded bituminous limestone is sometimes so much expanded (e. g. at Seefeld) as to occupy

a considerable portion of the formation. In the Bleiberg country specimens of *Gryphæa incurva* have been found in the calcareous system overlying the red sandstone; and the beautifully iridescent *Ammonites* have, by some geologists, been identified with the fossils of the lias. On the whole, the authors are led to conclude, that in the Bleiberg sections *grauwacke* with transition fossils, new red sandstone, and lias, are exhibited in regular succession.

On the north side of the axis the evidence is by no means so clear. The lower Alpine limestone is said on that side to contain a few *Ammonites* and *Belemnites*; and from the analogy of the Bleiberg section the authors conclude that its inferior portion is probably of the age of the lias. From its enormous development it is supposed to ascend into the oolitic series; but they possess no means of defining its superior limits.

5. *Limestone with subordinate saliferous marls, &c. &c.*—For a detailed account of this subdivision the authors refer to the published works of M. de Lill. It is obviously superimposed on the older Alpine limestone, and must not therefore be confounded with the inferior gypseous marls; it is not continuous, but appears in the form of enormous lenticular masses of gypseous and saliferous marls, and of sandstone often brecciated, &c. &c. These are associated with, and encased in, great masses and contorted beds of Alpine limestone. The several deposits, commencing at Halle and ranging through Berchtholsgaden, Hallein, Ischel, Hallstadt, and Aussee, though not strictly continuous, are supposed to be nearly on the same parallel. Several detailed sections are given in confirmation of the ideas of the authors, who in this part of the series appear to be in perfect agreement with the statements in the most recent works of Dr. Boué. There are great difficulties in ascertaining the upper and lower limits of this group, and also in determining its exact epoch. It contains some *Orthoceratites*, especially in the beds of limestone below the saliferous marls; but the greatest number of the fossils, *Ammonites*, *Belemnites*, *Pentacrinites*, with various bivalves and univalves, &c. &c., appear on the whole to conform to the types of the oolitic series,—a conclusion which is in accordance with the position of the deposit among the secondary formations of the Alps.

6. *Younger Alpine limestone.*—Under this designation are included all the secondary formations of the Alps, which are superior to the system containing the saliferous marls. The authors do not pretend to define correctly the lower limits of this great subdivision, but they place it somewhere in the upper portion of the oolitic series. The highest beds forming the outskirts both of the Italian and German Alps, they identify with the green-sand and the chalk. In the neighbourhood of Trieste, and on the eastern shores of the Adriatic, this upper system consists of micaceous shale and sandstone, with very rare traces of fossils, alternating with beds of Alpine limestone full of *Nummulites*.

The authors then describe the upper Alpine limestone in Austrian and Bavarian Alps. They point out its extraordinary contortions; the masses of dolomite into which it sometimes passes; its subordi-

nate deposits of gypsum and rauchwacke ; and its great masses of compact and subcrystalline limestone, sometimes containing innumerable Hippurites, &c. &c. They show that the higher part of the series is often made up of inclined and contorted beds of compact limestone, indurated shale, calcareous sandstone, &c. &c. containing Ammonites and Belemnites ; that the system here and there passes into a true green-sand with the characteristic fossils of that formation ; that a granular iron ore is worked in this part of the series at Sonthofen not distinguishable from some of the ferruginous green-sands of Kent ; that iron ore occurs in the same system south of Bregenz, associated with a nummulite-limestone and thick beds of shale. Finally, they state, that they found no great masses of conglomerate subordinate to this group. It is, however, here and there succeeded and surmounted by enormous masses of alternating sandstone and conglomerate ; which (as they graduate into beds containing tertiary fossils) are considered as the true base of the tertiary system.

7. *Tertiary deposits*.—The authors having described these deposits of the Austrian Alps in former papers, only return to the subject for the purpose of noticing some remarks which have appeared in the recent publications of Dr. Boué.

1. Dr. Boué is mistaken in supposing that they confounded the iron sand of Sonthofen with rocks of the tertiary age. It was described by them as containing Ammonites and Belemnites, and as alternating with beds of the newer Alpine limestone \* ; and they are surprised that Dr. B. persists without any grounds in attributing to them a contrary opinion.

2. Dr. Boué states that the tertiary formation of Häring is entirely of freshwater origin. The authors prove that it contains several species of marine shells ; from which they conclude (contrary to the opinion of Dr. B.) that the marine tertiary formations of the Alps do sometimes ascend far up the transverse, secondary valleys.

3. Dr. Boué maintains that the tertiary formations on the flanks of the Austrian Alps commence with the superior division of that great class of rocks. The authors on the other hand have shown by other transverse sections and suites of fossils, that some of the inferior groups of the tertiary deposits in the Gratz basin are of the age of the London clay. So far they consider that there is a difference between themselves and Dr. Boué on questions of fact.

4. They also differ from that author on questions of opinion.—The overlying deposits of Gosau, and in some of the lateral valleys of the Traun, were considered from their fossils as of an age newer than the chalk. He, on the contrary, identifies them with the *lower* green-sand. But the Gosau beds are unconformable to, and do not appear to form any part of the system of newer Alpine limestone or green-sand, &c. ; and they appear to be identical with certain deposits on the outskirts of the Alps, which are associated with the tertiary series. They are not interlaced with the secondary system,

\* See Annals, Jan. 1830, p. 53.



and do not contain Ammonites and Belemnites; in which respects they cannot be compared with the deposits of Sonthofen, &c. Out of more than 100 species of fossils collected from Gosau, there are from 30 to 40 species of bivalves, and of those capable of being identified, about equal numbers are referrible to the youngest secondary and the oldest tertiary formations.

The univalves are much more numerous than the bivalves, especially in the quantity of each species, a fact never observed in any deposit of secondary age. Amongst upwards of 50 species of univalves which the authors collected, three only are found in the chalk and green-sand, whilst 7 species are identical with known tertiary fossils; and several of the genera, such as *Volvaria*, *Pleurotoma*, and *Voluta*, they conceive have never been seen in any secondary formation.

In confirmation of their views, the authors refer to the catalogue of the Kressenberg fossils published by Count Münster, with whose opinions they coincide. They also refer to the lists of fossils found in the beds over the chalk near Maestricht, and they conclude that the deposit of Gosau, like that at Maestricht, forms one of the terms of a new series, younger than the chalk, and to be interpolated between that formation and the *calcaire grossier*.

The abstracts of the papers on the Tertiary Formations of Austria and Bavaria, published in the *Phil. Mag.* and *Annals of Philosophy*, for January 1830, were necessarily incomplete, and in some respects erroneous, owing to the detention at Paris of nearly all the fossils collected by the authors. This memoir contains the opinions of the authors, after a careful revision of all the facts, on which their conclusions are founded.

June 4.—Rev. Richard Dawes, M.A., Fellow and Tutor of Downing College, Cambridge; Rev. Charles Currie, M.A. Fellow of Pembroke College, Cambridge; Rev. Thomas Musgrave, M.A. Fellow of Trinity College, Cambridge; William Devonshire Saull, Esq. of Aldersgate Street, London; and Francis Ellis, Esq. of the Royal Crescent, Bath,—were elected Fellows of this Society.

A paper was read, entitled “On the Geological Relations of the South of Ireland, by Thomas Weaver, Esq. F.G.S. F.R.S. M.R.I.A., &c.”

This Memoir gives an outline of the mineral constitution of a large tract in the south of Ireland, comprising the counties of Cork, Kerry, and Clare, with part of those of Galway, Tipperary, and Waterford; and thus connecting this portion of the island with the eastern part of it, formerly described by the author.

This hilly and diversified region is chiefly composed of ridges, having generally a direction from east to west, and attaining their greatest elevation in the mountains of Kerry, where Gurrane Tual, one of Magillicuddy's Reeks, near Killarney (the highest land in Ireland), is 3410 feet above the sea.

The rocks in this elevated country are chiefly of the transition class: they decline gradually towards the north, and finally pass under the old red sandstone and carboniferous limestone of the midland counties.

### 1. *Transition Series.*

In Kerry there is a persistent series of transition rocks, having a general direction from east to west, and dipping to the north and south with vertical beds in the axes of the ridges: the strata as they diminish in inclination on each side, form a succession of troughs. The principal rock-masses are composed of grauwacke, slate, and limestone; but the general series is distinguished, by the author, into simple and compound rocks; the simple being clay-slate, quartz-rock, hornstone, lydian-stone, and limestone. The compound sandstone and conglomerates with bases of clay-slate, quartz, and sandstone; grauwacke, and grauwacke-slate; sandstone and sandstone-slate; greenstone; and hornstone-porphry. Roofing-slate, though comparatively rare, is found of an excellent quality in the island of Valentia.

Organic remains occur more frequently in the limestone of this series than in the slate and grauwacke. In Kenmare these remains consist of a few bivalves, and some crinoidal remains; and these also are most numerous in the Muckruss and Killarney limestones. At the foot of the Slieve-meesh range this limestone includes *Asaphus caudatus*, *Calymene macrophthalma*, and perhaps a third crustaceous animal, with *Orthoceratites*, *Ellipsolites ovatus*, an *Ammonite*, *Euomphalites*, *Turbinites*, *Neritites*, *Melanites*, and several species of *Terebratula*, *Spirifer*, and *Producta*. Other bivalves in this locality are referrible to species figured by Schlotheim, as from transition rocks on the Continent.

Near Smerwick harbour, similar organic remains are abundant in slate, and fine-grained grauwacke, together with *Hysterolites*, and many genera of polyparia; the whole resembling both in mineral and zoological characters the rocks of Tortworth in Gloucestershire, formerly described by the author, as well as those of the Taunus in Nassau, more recently described by Sir Alexander Crichton. Again, the same fossils are found in the limestone of Cork, associated with impressions of vertebræ of fishes; and analogous remains are to be met with also in a portion of the slate of that neighbourhood.

*Transition coal.*—All the coal of the province of Munster, except that of the county of Clare, is referrible to one of the earliest periods at which that mineral has been produced; the true coal overlying the mountain limestone being found in that county alone. At Knockasartnet, near Killarney, and on the north of Tralee, thin anthracitic beds, inclined at various angles from 70 degrees to verticality, are included in grauwacke and slate. In the county of Cork this old coal is more extensively developed, particularly near Kanturk, extending from the north of the Blackwater to the Allow. The gorges of the latter river, and various other neighbouring defiles, expose clay-slate, grauwacke, shale, and sandstone, in nearly vertical beds, directed from west to east. This transition tract extends to the river Shannon on the north-west. As the systems range from west to east, in a series of parallel, acutely angled troughs, the beds have great diversity of inclination, dipping rapidly either to north or south, and bending to horizontality between the ridges. This coal or

anthracite is raised in sufficient quantities for the purpose of burning the limestone of the adjoining districts; and the most considerable collieries, those of Dromagh, have yielded 25,000 tons per annum, at from 10s. to 15s. per ton.

The coal, and accompanying pyritiferous strata are abundantly charged with the remains or impressions of plants, belonging chiefly to *Equiseta* and *Calamites*, with some indications of *Fucoides*. Beds of transition coal occur also in the county of Limerick, on the left bank of the Shannon, north of Abbeyfeale, and at Longhill; and are seen, though in very small quantity, on the right bank of the river at Labbasheada. Several other places where coal strata occur, are mentioned by the author.

The transition rocks of Kerry and Limerick are prolonged into Cork and Waterford, preserving with certain modifications an analogous character and composition. The carboniferous limestone reposing upon this tract, on the north, is usually unconformable to it, but is conformable to the old red sandstone, wherever that rock intervenes. In this system of strata, organic remains, such as *polyparia*, bivalves, *Trilobites*, &c. occur near the Bonmahon river; the horizontal planes which they occupy crossing the vertical cleavage of the slaty grauwacke nearly at right angles. The series rests upon, and passes into clay-slate, and is capped by old red sandstone and strata of the carboniferous order. Metalliferous veins with indications of copper and lead are seen in the cliffs of the transition series, east and west of the Bonmahon river.

## II. *Metalliferous relations in Kerry and Cork.*

The author having succeeded in restoring the copper mines at Ross Island, on the Lake of Killarney, and in effectually draining off the water, was enabled to prove that the ore did not constitute a metalliferous bed, or any real vein, but was contemporaneous with the rock in which it is irregularly distributed in the form of ribs, branches, strings, &c., analogous to those of calcareous spar, in limestone. The rocks at Ross Island consist of blue limestone, and beneath it of siliceous limestone, but the ore is confined exclusively to the former; and various trials have proved the non-existence of any vein communicating with the metalliferous deposit. Copper ore is similarly distributed at Crow Island:—but at the Muckruss mines the ore was obtained chiefly from a metalliferous bed. The author has ascertained exactly the extent of the limestone bearing lead in Kenmare, where most of the unsuccessful trials in search of ore have shown that the mineral deposits are discontinuous, and nearly parallel to the range and dip of the beds; and in Castlemaine mine, where lead ore was formerly worked in a mass of calcareous spar and quartz, it thinned out into an unproductive pipe. Near Tralee and Ardfort, and on the left bank of the Shannon, lead ore has been unprofitably worked in limestone, sandstone and slate.

In the county of Cork, the copper mines are those of Allihies, Audley, and Ballydehol; and those producing lead are situated at Doneen and Rinabelly. The mine at Allihies is one of the richest mines in Ireland; it was discovered only in 1812, and has already

yielded more than 2000 tons of copper ore per annum. The ore occurs in a large quartz-vein, which generally intersects the slaty rocks of the country from north to south, but in some places runs parallel to the stratification. It is remarked that all this portion of the county of Cork indicates a very general diffusion of cupreous particles, so much so, that in the year 1812 there existed a cupriferous peat-bog on the east side of Glandore harbour, forty or fifty tons of the dried peat producing when burnt, one ton of ashes, containing from ten to fifteen per cent of copper. The lead mines of Doneen and Rinabelly are in slate.

In concluding a long series of observations on the mines of the tracts described in this paper, the author remarks that the diffusion of metallic substances throughout the mass of rocks is far from being an uncommon occurrence—the metalliferous matter appearing in isolated particles, and in strings, veins or filaments, more or less connected with each other, but not continuous or persistent, and therefore of contemporaneous origin with the rock itself.

### III. *Carboniferous series of Clare.*

The clay-slate formation in this county is bordered by a belt of old red sandstone, to which succeed, in ascending order and conformable position, the mountain limestone and coal measures, both of which occupy flat and undulating hills, and the strata usually dip from the east of north to the west of south; but seldom at a greater angle than  $5^{\circ}$ . The best sections are seen in the cliffs of the west coast, where shale, sandstone and sandy-flag-stone overlie limestone. Coal, however, is there of very rare occurrence, and when disclosed is of very indifferent quality; and the author infers, that the lower part of the series in the county of Clare is comparatively poor in this mineral: he, however, suggests that the best chances of discovering valuable seams must lie in the elevated regions of Mount Cullun; where if coal be found, the beds being nearly horizontal, it might be worked with advantage.

The Memoir concludes with some observations on the distribution of diluvial matter in the South of Ireland.

1. Boulders, gravel and sand, derived from the transition series are lodged along the borders and sides of the mountains in Kerry.

2. In a small district of Limerick and Tipperary, situated between the Gaultees and Slieve-na-muck, the rolled debris consist not only of portions of the contiguous rocks, but contain also porphyry, which is not to be found *in situ* near the vicinity of Pallis Hill.

3. In the peninsula of Renville, near Galway, the surface of the carboniferous limestone is strewed over with numerous boulders of red and gray granite, syenite, greenstone, and sandstone, which must apparently have been conveyed from the opposite side of the bay of Galway.

June 18.—Robert Dawson, Esq. of the Royal Engineers, and employed on the Ordnance Survey of Ireland, was elected a Fellow of this Society.

A letter on the Basin of Alhama, in the Province of Granada, in

Spain, being the second of two letters addressed to Roderick Impey Murchison, Esq., Sec. G.S., F.R.S. &c., by Col. Charles Silvertop, F.G.S., was then read\*.

The basin of Alhama is situated about 50 miles to the south-west of the basin of Baza, which was described in the former letter. It occupies a large circular area, bounded on the south and east chiefly by the primitive chain of the Sierra Nevada, and on the north-west and south-west by ridges of nummulite-limestone. The greater diameter of the basin, namely, between the village of Huerta de Santillana on the north, and the ridge near Alhama on the south, is about 36 miles; and the smaller diameter, between the village of Escujar on the east, and the town of Loja on the west, is about 30 miles. The principal river traversing the basin is the Genil, which takes its rise in the Sierra Nevada to the east of Granada; and having received all the minor streams which water the basin, it passes through a chasm in the nummulite-limestone near Loja, and afterwards unites with the Guadalquivir.

The whole area of the basin, with the exception of an insulated group of transition limestone rocks near Granada, is occupied by conglomerates, marl, gypsum, and limestones containing freshwater shells. The conglomerates predominate to the north and east of Granada, and form a high tract of waving hilly ground between that city and the eastern part of the Sierra Nevada; and the other deposits prevail through the southern portion of the basin. The valley through which the Genil flows is the lowest part of the district, and is composed near Granada of a disintegrated conglomerate.

The author gives a detailed account of the geological appearances presented along the line of road from Granada to Alhama. The lower strata consist of beds of gypsum alternating with strata of marl and marly, micaceous sandstone. The gypsum is in general of the ordinary, fibrous variety; but near the village of Escuzar, alabaster of a beautiful whiteness is quarried. In the bed of a rivulet passing by La Mala a brine-spring issues, which yields from 18,000 to 24,000 fanegas of salt yearly; the fanega being equal to 25lbs Spanish. The strata of marl and gypsum are covered with a compact limestone, containing casts of Paludina; and on this limestone rest irregular masses composed almost entirely of comminuted shells of the genera Limnæa and Planorbis. The fossils found in these limestones have been examined by Mr. J. Sowerby, who has supplied the following list:—

Planorbis rotundatus, found in the Isle of Wight.	Paludina pusilla, of Deshayes.
Planorbis rotundatus vel planulatus.	Paludina Desmarestii.
Planorbis, new species.	Paludina pyramidalis.
Bulimus pusillus, of Broard.	Ancylus.
	Cypris.
	Limnæa.

The structure of the country around Alhama is explained by three sections in the immediate vicinity of that village. One of these, observed by following the horse-road from Alhama towards Loja, presents

\* For the first letter, see Phil. Mag. and Ann. of Phil., vol. vii. p. 453.

in an ascending order the following succession of horizontal strata, and may be taken as the type of the others.

1. The nummulite limestone, which constitutes the boundary of part of the basin.

2. A coralline limestone, which in some parts alternates with a calcareous sandstone and a fine-grained conglomerate ; the sandstone abounds with a *Pecten*, which resembles the *Pecten reconditus* of the London clay.

3. The rock composed of alternate strata of gypsum and marl.

4. The freshwater limestone with *Paludina*, above described, which forms a table land, extending in the direction of Loja as far as the eye can reach.

Under the freshwater limestone, near the village of Arenas, is a large deposit of brown coal of unknown depth. The remains of *Planorbis* are abundant in the upper layers of it.

In conclusion, the author states that he had observed a compact limestone containing *Limnæa* and *Planorbis*, near Partaloba, in the province of Granada ; Montesa, in the province of Valencia and La Gineta ; and Ocaña, in the province of La Mancha ;—that he had likewise ascertained the existence of an extensive lacustrine basin near the town of Terruel in the province of Arragon, composed of a coarse limestone containing *Limnæa pyramidalis* (a fossil of the Isle of Wight), resting upon gypsum and marl.

At the close of this Meeting, which terminated the Session, the Society adjourned till Wednesday Evening, the 3rd of November.

PROCEEDINGS  
OF  
THE GEOLOGICAL SOCIETY OF LONDON.

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1830-1831.

No. 18.

Nov. 3.—In consequence of the Resolutions passed at the general meeting held on the 18th of last June, changing the evenings of ordinary meeting from the first and third Fridays in each month, from November to June, inclusive, to the alternate Wednesdays, the Society assembled on this evening for the session.

The Rev. Thomas Boyles Murray, M.A. of Hart-street, Crutched Friars; James Edward Winterbottom, Esq. M.A. of Southampton-buildings; William Taylor, Esq. of Canonbury-square; Charles Shaw Lefevre, Esq. of Whitehall-place; Rev. Dr. Arnold, headmaster of Rugby School; Henry Ellis, Esq. of Welbeck-street; the Right Hon. the Earl of Selkirk; and Dr. Bayne of Trinity College Cambridge;—were elected Fellows of this Society.

The reading of a paper entitled "Remarks on the Formation of Alluvial Deposits," by the Rev. James Yates, M.A. F.G.S., F.L.S., was begun.

Nov. 17.—The Rev. William Kirby, M.A.; Prideaux John Selby, Esq. of Twizell-house, near Belford, Northumberland; and James Dickson, Esq. of Kidbrooke, Blackheath; were elected Fellows of this Society.

The reading of the paper on the Formation of Alluvial Deposits, by the Rev. James Yates, begun at the last meeting, was concluded.

After adverting to the importance of this branch of Geology towards the successful study of all the more ancient sedimentary deposits, and to the explanation of the methods by which bare rocks are converted into productive soils, the author proposes to describe some of the processes which regulate the production of alluvium, and the principal forms which it assumes.

I.—He considers first those processes of disintegration, not dependent upon the action of running water, by which materials are supplied for the formation of alluvium. These are of two kinds.

1.—Earthquakes and landslips, by which large masses are detached suddenly from the mountains, and fall occasionally with so great an impetus as to extend across valleys.

2.—Other processes, such as frost and oxidation, which are far more important in their effects. The agents of this class always divide rocks according to their natural structure of separation, so that every fragment of the debris is bounded by the plane of its cleavage. The fragments as they fall produce two principal forms;

(a) the lengthened talus, which in general covers the base of all calcareous, and conglomerate or sedimentary rocks; and (b) the acute cone, which is discharged from the ravines of highly inclined schistose rocks, having a cleavage which meets the planes of stratification at an acute angle.

II.—The materials thus furnished are distributed by streams, which round off their angles by continual friction, so as to convert them into pebbles, sand, and mud. The hard and heavy fragments driven along by streams, also wear down the rocks in place, the latter being acted upon according to their degrees of softness and their proneness to disintegration.

When the detritus thus produced is discharged from a lateral into a principal ravine, or valley, the divergence of the stream gives it the form of a cone; but as the force of running water carries loose materials much further than they would fall by their own weight, the form thus produced is not an acute but an obtuse cone. In the Alps some of these obtuse cones attain 500 feet in height, and three miles in diameter, bearing upon their surfaces forests and villages.

The quantity of solid materials descending over the apex of an obtuse cone, is sometimes so great as to stop up the valley. The waters of the principal stream then accumulate above the obstruction, and after the subsidence of the lateral stream, tear away the base of the encroaching cone. This form the author designates as the obtuse cone clipt at the base.

Narrow valleys and plains are frequently divided by transverse ledges of gravel. The formation of these is attributed to the operation of rivers, which it is supposed had first accumulated their detritus in dams, and that these dams, having been successively broken down after the subsidence of floods, were re-produced upon a rise of the streams.

Numerous causes are assigned which vary the depth of streams. These are, rains; the melting of Alpine snows and glaciers; the breaking up of ice in rivers; and the bursting of lakes.

III.—Whenever detritus is conveyed by running into standing water, a separation takes place between those finer particles which are held in suspension, and those which it only rolls along the bottom.

As the debris of horizontally stratified rocks forms a lengthened talus at their base, so the loose and heavy materials washed down the side of a mountain, and conveyed into a lake, as soon as they reach its margin fall in a steep slope of the same description. Layer after layer is thus deposited, the result of which is, that a terrace is gradually formed, dipping under the surface of the lake with a gentle slope, and then abruptly terminating in a steep declivity.

The author next endeavours to show, that what is commonly called a Delta is more strictly speaking the Sector of a Circle.

After describing numerous examples of forms of alluvial matter, in artificial reservoirs and in lakes, the author alludes to the probable



existence of similar deposits upon a vast scale in the deep and still waters of the ocean; and considering the English, St. George's and Bristol Channels, to be of the nature of estuaries, he observes, that the arc of the Sector is found encircling the south-western extremity of Ireland on the one hand, and the north-western angle of France on the other, and coinciding with a line along which the water deepens suddenly from one hundred to more than two hundred French fathoms.

It is then shown that lakes are filled up, not by depositions in their deep, central water, but by the gradual advance of all their lateral terraces and cones.

IV.—When two streams meet, they neutralize each other's motion, and a deposition takes place at the point of quiescence.

Peculiar appearances ensue, when streams meet at different levels. If a lateral stream brings down a disproportionate quantity of detritus, its bed is raised, but is abruptly terminated by the action of the principal stream. Hence the valleys of mountainous regions exhibit not only level terraces formed in lakes, but others the edge of which have a steep declivity.

Finally, the author presumes that the forms which alluvium puts on in rivers, are produced also in seas, and in the ocean, by the opposition and union of currents flowing either at the same or at different levels.

A short Memoir was then read, entitled "Remarks on the Existence of Anoplotherium and Palæotherium in the Lower Fresh-water Formation at Binstead, near Ryde, in the Isle of Wight," by S. P. Pratt, Esq. F.G.S. F.L.S.

The author lately discovered, in the lower and marly beds of the quarries of Binstead, in the Isle of Wight, and which belong to the lower fresh-water formation, a tooth of an Anoplotherium, and two teeth of the genus Palæotherium, animals characteristic of strata of the same age in the Paris basin.

These remains were accompanied, not only by several other fragments of the bones of Pachydermata (chiefly in a rolled and injured state), but also by the jaw of a new species of Ruminantia, apparently closely allied to the genus Moschus. From the occurrence of the latter fossil, the author infers that a race of animals existed at this geological epoch, whose habits required that the surface of the earth should have been in a very different state from that which it has been supposed to have presented, in consequence of the frequent discovery of the remains of animals who lived almost entirely in marshes.

Dec. 1.—The Rev. Daniel Petteward, M.A. of Trinity College, Cambridge; and John William Bowden, Esq. M.A. of Grosvenor-place, London, were elected Fellows of this Society.

A paper was read, entitled "An Explanatory Sketch of a Geological Map of Moravia, and the West of Hungary," by Dr. A. Boué, For. Mem. G.S. &c.

The author in presenting this Map to the Geological Society, states that it has been made with the assistance of Messrs. Teubner, Rittler, and Von Lill von Lilienbach; and that with the latter

gentleman, in particular, he has recently worked out many details, which it is hoped may rectify certain errors in the great Geological Map of Germany, published by Schropp of Berlin.

Moravia has been in part described by André, Von Albin Heinrich, Von Lill, Von Oeynhausén, and Beudant; but the two last-mentioned writers, it is stated, have not visited the country.

This region is made up of the union of three principal chains of hills, the Eastern or Böhmerwaldgebirge, the Sudeten or Silesian mountains, and the Western Carpathians, the contact of the two first of which is hidden by a red sandstone of the coal-measures, and green-chalk-marl.

The hilly region called the Gesenke, consists of grauwacké, and extends across Moravia to near the Bohémian range. The Gesenke is separated from the Carpathians by the tertiary and alluvial valleys of the Upper Oder.

The more ancient and longitudinal valleys, in Moravia, have a general direction from W.S.W. to E.N.E.; and are, with some few exceptions, cut through transversely by the present streams.

In the part of Hungary and Gallicia indicated on this Map, the rivers on the contrary flow for the most part in longitudinal valleys, parallel to the Carpathians, as the Nitra, Gran, Vistula, and the Waag, although the latter for a certain space runs through a transversal rent in primary rocks.

In the Western groups are numerous Scotch and Scandinavian minerals. Many of the oldest stratified rocks are crossed by large, dyke-like, elliptic bodies, running from south-west to north-east. The respective characters of the primary Sudeten and Tatra mountains are then described. The grauwacké districts are stated to differ little from those of the Hartz and the South of Scotland; and the caverns which abound in the blueish gray limestone, subordinate to this formation, may, the author conceives, have been produced by the acidulous waters which are still so abundant in the country, as at Gefatter Loch, &c. This old limestone formation abounds in Madreporés, Caryophyllia, Encrinites, and Orthoceratites.

The author is of opinion, that the sienite was erupted during the period between the formation of the grauwacké, and the primary chain of Bohemia. This sienite has very various characters, being sometimes porphyritic, at other times associated with talcose and quartzose rocks, &c.

Above the sienite lies a coarse, red conglomerate, which is connected in Bohemia with a great deposit of red sandstone with coal. Here the author corrects an error in Schropp's Map, where the district is coloured as new red sandstone; instead of which, he considers it to be of the age of the Scotch red coal-grits.

The other coal deposit of the basin of the Oder is in aluminous and bituminous slate, with gray sandstone, and many vegetable impressions, but without red sandstone.

The *Zechstein* is wholly absent in these parts, and the true red marl is very scarce.

The *Muschelkalk*, however, occupies some space in Upper Silesia and Poland, and contains most of its characteristic fossils.

The Jurassic and Alpine limestones extend over a large portion of the Map; and the dolomite, the upper beds of which abound with *Madrepores*, *Encrinites*, *Diceras*, and *Terebratulæ*, is overlaid by the Carpathian or Vienna sandstone (Andrychow, &c.).

The Carpathian sandstone fills a cavity between a range of true Alpine limestone on one side, and Jura limestone on the other, and is easily divisible into three parts.

1. The lowest division is marly and calcareous, containing *Fucoides intricatus* and *F. furcatus*, and has been mistaken on Schropp's Map for transition limestone. It is cut through by dykes of serpentine and greenstone.

2. The middle group is more quartzose.

3. The highest is characterized by reddish marls, several beds of ruiniform, compact limestone, some *Fucoides*, *Encrinites*, *Lepadites*, *Tellinites*, resembling those of Solenhofen; *Posidonia*, *Terebratulæ*, *Ammonites*, and *Belemnites*. This triple system of the Carpathians is overlaid by a group of sandstone which the author considers to be the "green-sand;" this is composed of conglomerate, nummulite limestone, and green, calcareous beds with *Gryphæa columba*, *Ostrea vesicularis*, &c., also with superior beds resembling the *Planer Kalk* of the Germans. The greensand of Moravia has all the characters of that of North-western Europe, passing upwards into a superior, marly greensand, with fossils, and forming long, continuous plateaux. For details the author here refers to previous publications of his own, and to sections with which his Map is accompanied.

Chalk does not exist in the Carpathians, nor could the author recognise it at Cracow, the limestone of which he refers to the Upper Jurassic, although he states that chalk is found in the plains of Poland, Eastern Galicia, Podolia, Volhynia, and Southern Russia.

The tertiary deposits of the countries described, though belonging to two distinct basins, have everywhere the same characters. The low grounds of Galicia are supposed to have formed a part of the great basin of Northern Europe, which must have connected the Baltic with the Black Sea, and perhaps with the seas and lakes of Asia. The tertiary beds of Moravia, on the contrary, he considers to have been deposited in an arm of that sea, which must have occupied the great depressions of Hungary and Austria, communicating with the Mediterranean through Bavaria and Switzerland, inasmuch as these deposits, whether on the North or on the South of the Carpathians, have a common character. The various tertiary groups are identified with those of the sub-Apennines; the blue marls, and yellow, sandy marls, besides the characteristic shells, contain salt, sulphur, gypsum, &c.; and in some parts there are fresh-water shells, including the *Mytilus* of the Danube. In respect to the place of the salt of Wieliczka, the author, differing from MM. von Lill and Keferstein

who had placed it in the Carpathian sandstone, considers it to be of tertiary age, because it is associated with sub-Apennine shells, and is connected with upper marine sandstone, and limestone.

Above the blue saliferous marls is a vast extent of *molasse* with Pectens, Ostreæ, and many fossil vegetables. The beds of this deposit are highly inclined along the foot of the Carpathians. At Nicholschitz and Krepitz in Moravia, and at Zazlusin and Dobromil in Gallicia, it is represented by marly, siliceous deposits, with semiopal, and fishes, as well as Hymenopterous, Dipterous, and Coleopterous insects.

The sandy banks, with Ostreæ and Cerithia, which abound in Moravia, Hungary and Gallicia, are referred to an age intermediate between the blue saliferous marl and the *molasse* just described, and are considered to be older than the conglomerates and coral limestone of Austria.

The older alluvium of these districts, and particularly that of the valley of the Oder, besides boulders and gravel, contains existing species of fresh-water shells mixed in beds of marl with bones of extinct animals and fossils.

Of basaltic rocks, the cone of Randenberg is scoriaceous, and has been protruded through grauwacké. Near Barrow a felspathose rock has pierced the Carpathic sandstone, converting it into jaspideous rocks resembling those of the Giant's Causeway, and the Isle of Skye, &c.

The author refers to M. Beudant for full particulars of the trachyte, but begs to distinguish certain trachytic conglomerates, as being of aqueous origin, from the trachytic or igneous breccia.

An original manuscript Map of all the districts described in the previous Memoir of Dr. Boué, was presented by M. von Lill von Lilienbach, who amongst other novelties has discovered two cones of trachyte near the mercury mines, in the Carpathian sandstone of Krosciensko.

Dec. 15.—The Rev. William Turner, M.A. of Christ Church Oxford, and Trinity College Cambridge; Anthony Todd Thomson, M.D., F.L.S., Professor of Materia Medica and Therapeutics in the University of London; and George Townshend Fox, Esq., F.L.S., and F.Z.S.;—were elected Fellows of this Society.

A paper was first read, entitled "An Explanatory Sketch of a Geological Map of Transylvania," by Dr. Ami Boué, For. Mem. G.S.

The author premises that this sketch, having been written before his specimens were unpacked, is necessarily incomplete, both from that cause and from various impediments which obstructed his observations.

Transylvania is described as being chiefly occupied by a high tertiary basin, surrounded by four chains of mountains, viz.: 1. On the south by the primary range of Wallachia or Taganrasch. 2. On the west by another primary range, usually omitted by geographers; and connected with a high calcareous chain near Kronstedt, and a ridge of Carpathian sandstone near the pass Oytosch. 3. By the trachytic hills separating the low tertiary and saliferous districts from the great

valley of the Secklerland. 4. By a large group of conical porphyritic hills, with metalliferous summits, ranging by Korosch Banya, Zalahria, Vorospatak, &c. Many of these hills are stated to average from 3000 to 4000 feet in height, and the highest peaks to exceed 6000 feet. The author, describing the course of the rivers, remarks that the hydrographical features are inaccurately given in all maps, and that most of the streams cut through the above chains by gorges of very recent fracture. The primary rocks, he says, consist of gneiss and slate; that in the latter, serpentine, granular limestone, and metalliferous veins are found wherever sienite comes into contact with the slate. The Carpathian sandstone with Fucoids (Vienna sandstone) is mentioned as occurring in the N.E. and S.E. of Transylvania;—that it surrounds the auriferous porphyries of Nagy and Banya, and that at Laposbanya the marls and slaty sandstones of this formation are much altered by dykes of sienitic porphyry, presenting examples of jaspideous rocks like those of Portrush, Skye, &c.

The author is disposed to think that there are evidences of two or even more periods of igneous eruption, and that the scoriaceous trachytic porphyries cut through and frequently overflowed the metalliferous porphyries. These porphyry districts are cited as offering repeated and decisive proofs of the igneous origin of metalliferous veins; all the walls of which are altered and discoloured:—large masses of the rock are traversed by millions of auriferous rents,—and that gold is found in the sandstone as well as in the porphyry.

The remaining secondary formations are stated to consist of a kind of recent Jurassic, compact limestone, associated with conglomerate, covered, here and there, by patches of sandstone and marl containing some of the fossils of Gosau. Near Sass Vorosch, Kis Numtschel, Kis Aranyos, &c., deposits of about the same age are said to have been observed by M. Partsch, and that they have been further described in the Buskowitz by that gentleman, and by Messrs. Von Lill and Rudolph. The tertiary deposits, like those of Hungary, are considered to be entirely of the upper class, and they are shown to consist of clay, marl, and molasse, with salt, gypsum, lignite, &c. The molasse, the author says, is generally covered by shelly sands and gravel, but occasionally by a sandy, coarse limestone; and that near Illyefalva à Arapatak, these sands contain many freshwater mixed with some marine shells. Near the Rothethurm pass, and west and north of Klaurenburg, he shows there are thick deposits of nummulitic and coral limestone, equivalent to the highest tertiary limestone of Austria and Hungary. Fichtel is quoted as the earliest and best geological writer upon Transylvania, particularly as to the localities of shelly deposits and salt springs; and it is stated that from his work alone M. Beudant was enabled to compile a map of this country.

For an account of the eastern chain of trachytes the author refers to what he has already written in Dr. Daubeny's work on Volcanos:—he inclines to the supposition that the scoriaceous trachytic porphyries were erupted during the cretaceous or perhaps even during the old tertiary period; and he dissents from M. Beudant as to the possibility

of drawing any distinct line of demarcation between the trachyte and porphyry in those places where these rocks are contiguous, although when at great distances from each other he allows the dissimilarity of their respective characters. A stratified, pumiceous and trachytic conglomerate, it is stated, frequently overlies the salt in Transylvania, and contains impressions of dicotyledonous plants, leaves, and fishes. The extinct craters of St. Annalake and the solfatarra still burning in the trachyte of Budoskegy, and the many acidulated and mineral springs, are considered by the author clearly to indicate the recent age of some of the volcanic phænomena in this country, to the principal entrance of which, the Romans assigned the name of "Vulcan's Pass."

A paper was then read, "On the Astronomical Causes which may influence Geological Phænomena;" by J. F. W. Herschel, Esq. F.R.S. F.G.S., &c., &c.

The author states his object in this paper to be, an inquiry into the possible geological influence of slow periodical changes in the orbits of the earth and moon, such as have been demonstrated by geometers to take place in consequence of planetary and solar perturbation. Such influence he regards as extending only to the production of changes in the amount of the tides and their consequent erosive action on our continents, and of periodical fluctuations in the quantity of solar heat received by the earth, every such fluctuation being of course accompanied with a corresponding alteration of climates; and therefore, if sufficiently extensive and continued, giving room for a variation in the animal and vegetable productions of the same region at different and widely remote epochs.

The subject of the tides is first considered. Since any approach of the moon to the earth produces an increase of the lunar tide in the triplicate ratio of such approach, it follows that any diminution of the moon's mean distance must produce an increase in the average tide during the whole period that such approach subsists. The mean distance of the moon is actually on the decrease, and has been so for ages past, producing the astronomical phænomenon of her *secular acceleration*. The mean amount of the tides, therefore, has long been, and will long continue to be, on the increase from this cause, but the effect of it is shown to be confined to such moderate limits as to be of no geological importance.

The author next considers the possible effect of an increase in the excentricity of the lunar orbit, which would affect not the *average* but the extreme rise and fall of the tides. Such an increase, however, he regards as necessarily limited, so as to be incapable of producing such an enormous increase of tides as would account for any of the greater diluvial phænomena, though possibly cases of great local devastation in estuaries and confined channels would arise, and the outlines of the continents, in particular parts of their coasts, might be materially modified by such increased occasional action. No change in the earth's orbit within the limits of possibility would produce any material change in the solar tides.

He next considers the effect of planetary perturbation on the

earth's orbit, and, dismissing the variation of the obliquity of the ecliptic, which is known to be confined within very narrow limits, he regards the excentricity as the only element whose variation can possibly have any effect of the kind in view; and that by affecting, first, the mean, and secondly, the extreme quantities of solar heat received by the earth in its annual revolution, and at the different seasons of the year. First, with respect to the mean quantity, he announces as a consequence of geometrical reasoning, the following theorem:—*That the mean annual amount of heat and light received from the sun by the earth, is inversely proportional to the minor axis of the ellipse it describes at different epochs.* And since the orbit of the earth is actually, and has been for ages, beyond the records of history, becoming less elliptic, and the minor axis consequently increasing, it follows that the mean temperature of its surface is on the decrease. The orbit being now very nearly a circle, this decrease cannot go much further; but should it ever have been very elliptic, the mean temperature must have been sensibly greater than at present. The author regards the limits within which the earth's excentricity is confined, as (although calculable) not actually known; and he denies in particular that the theorem demonstrated by Laplace, in the 57th article of the Second Book of the *Mécanique Céleste*, equation (*u*), which is usually cited as proving the narrowness of such limits, affords any ground for that conclusion in the case of the earth's orbit, however it may do so for those of the great preponderant planets.

Under this uncertainty he considers himself authorized to assume, that excentricities *actually existing* in the orbits, both of superior and inferior planets, may not be *impossible* in that of the earth; and admitting this, he calculates the mean and extreme amounts of solar radiation in an orbit so circumstanced. The mean amount he finds to exceed the present by about three per cent, a quantity apparently small; but he adduces considerations tending to show, that on certain suppositions not impossible or improbable in themselves, this percentage on the whole quantity of solar heat may have influenced our climates to as great an extent as geological indications appear to require.

Considering next the extreme effects of such a state of things, and adopting a view taken by Mr. Lyell in his *Geology*, he shows that by reason of the precession of the equinoxes combined with the motion of the apogee of the earth's orbit, the two hemispheres would alternately be placed in climates of a very opposite nature, the one approaching to a perpetual spring, the other to the extreme vicissitudes of a burning summer and a rigorous winter; and that, during periods sufficiently long to impress a corresponding character of the vegetable and perhaps the animal productions of each.





PROCEEDINGS  
OF  
THE GEOLOGICAL SOCIETY OF LONDON.

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1831.

No. 19.

Jan. 5, 1831.—A paper was read entitled, “On the general structure of the Lake Mountains of the North of England, and on the great dislocations by which they have been separated from the neighbouring chains;” by Prof. Sedgwick, M.A. Pres. G.S. F.R.S.

The country, of which the author hopes to give a detailed description in a series of communications, is bounded to the west and the south by the waters of the Irish Sea and Morecambe Bay. Towards the north it descends into the plain of the new red sandstone within the basin of the Eden; and on the east side it presses against, and partly encroaches on, the central carboniferous chain of the north. Within these limits are found two distinct classes of rocks, all the central region being composed of crystalline unstratified rocks, irregularly associated with great formations of schist, which are subdivided (agreeably to the system first published by Mr. Otley of Keswick,) into three well defined groups; while on the outskirts of these older formations is a broken zone of carboniferous limestone, and extensive deposits of superior [secondary] strata. The author avoids all mineralogical details; and after noticing the effects produced by the several formations on the external features of the country, describes at great length the range of a band of transition limestone (from Millam in Cumberland, to the neighbourhood of Wasdale Head in Westmoreland) nearly across the whole physical region under consideration; and states that it is finally cut off by a protruding boss of granite, which he regards as newer than the limestone. Upon this description he founds the following conclusions.

1st. Great cracks and fissures were formed at a very ancient period, diverging from the central regions, and intersecting the line of bearing of the strata. All the great valleys in the range described, are scooped out in the prolongation of these breaks, which were in all cases accompanied with internal movements; the present position of the systems of strata on the opposite sides of a transverse valley sometimes indicating a relative lateral movement of more than a mile in extent. These singular changes of position are referred partly to a true lateral shift, and partly to subsidence. Reasoning from analogy, the author concludes that all the great diverging valleys of the Lake Mountains took their origin in fissures probably formed during the period of the protrusion of the central syenite and granite.

2ndly. He observes that the upper and lower systems of the slate

rocks are often violently contorted; while the central system, though cracked and fissured as above described, hardly ever exhibits the indications of any flexures. This is explained by the presence of enormous unbending masses of compact felspar, porphyry, &c., which are so intimately associated with the middle division of the slate that the formations cannot be separated. The appearance is explained by referring the felspathic rocks to some modification of sub-marine volcanic action; by supposing that igneous and aqueous causes acted together, and that the operations were many times repeated.

3rdly. The mean line of bearing of the different systems is shown to be nearly N.E. by E., and S.W. by W. This makes them, one after the other, to abut against the carboniferous zone; from which it follows that they must also be unconformable to it. The author confirms this inference by referring to detailed sections; and, from the whole of the evidence, he concludes, that the central Lake Mountains were placed in their present position,—not by a long-continued, but by a sudden movement of elevation, before or during the period of the old red sandstone.

Lastly, He enters into some details, from which he endeavours to show, that if lines be drawn in the principal bearing of the following chains (*viz.* the southern chain of Scotland from St. Abbs Head to the Mull of Galloway; the grauwacké chain of the Isle of Man, the slate ranges of the Isle of Anglesea; the principal grauwacké chains of Wales, and the Cornish chain), they will be nearly parallel to each other, and to the line of bearing of the Lake Mountains, as above indicated. The elevation of all these chains is referred to the same period; and the parallelism is not regarded as accidental; but as a confirmation of one of the great principles upon which are founded some of the most beautiful generalizations of the Essays recently published by M. Elie de Beaumont.

The author next describes the system of faults by which the Lake Mountains were broken off from the central carboniferous chain. After some speculations on the original extent of the carboniferous deposits, which were spread out from the Scotch border to the central plains of England, and perhaps continuous with the similar deposits on the Bristol Channel, he points out some peculiarities of the western coal-fields.

1stly. The axes of the several contemporaneous basins are not parallel.

2ndly. The causes which produced this arrangement appear to have partially affected the then neighbouring grauwacké regions. Thus the transition slate of North Devon does not range parallel to the mean bearing of the grauwacké chain, but to that of the Welsh coal-field.

3rdly. These coal-fields are contrasted with the carboniferous chain of the north, extending from the latitude of Derby to the mouth of the Tweed: and it is inferred, from the nature of the beds resting on the edges of the dislocated strata, that the elevations of the south-western and northern systems were not perfectly contemporaneous.

4thly. The coal-fields of the Bristol Channel have no well-defined line of bearing, and have produced but small effects on the range of the superior secondary formations, which from the south coast to the latitude of Derby are nearly parallel to the mean range of the grauwacké chains above indicated. On the contrary, the great carboniferous chain north of Derby has produced a direct influence on the bearings of the newer formations.

He then briefly describes the structure of the great carboniferous chain of the North of England. The forces of elevation appear on the whole to have acted (though not without considerable deviations) on a line bearing nearly north and south. The position of the High Peak limestone, and the great north and south faults on its western side, are first noticed; and the axis of elevation is continued by help of an anticlinal line through the region of millstone grit, separating the Yorkshire and Lancashire coal-fields. The reappearance of the carboniferous limestone, its high elevation, and prolongation to the Scotch border, and the faults which range near its western escarpment are then noticed; and the great Craven fault (described in detail by Mr. Phillips) is traced still further towards the north from the hills of Barbondale to the foot of Stainmoor. The nature of the dislocations is illustrated by sections; and it is shown that the prolongation of the Craven fault from Mollerstang to Stainmoor foot has thrown down the carboniferous system with an inverted dip into the valley of the Eden, and produced a dislocation precisely similar in kind to that near Ingleton, described in detail by Mr. Phillips, and indicated in one of Mr. Conybeare's sections.—It is further shown that these dislocated mountain masses, becoming more expanded and less inclined, are prolonged without any further break of continuity into the northern zone of the Lake Mountains. A great fault which ranges at the foot of the Cross Fell Chain, and meets the Craven fault at the foot of Stainmoor at an obtuse angle, is then described; and it is shown that when it strikes the carboniferous chain above Brough, an effect is produced precisely similar to that which accompanies the prolongation of the Craven fault. By the intersection of these faults, the very complex relations of the mountain masses, in the last ramifications of the Eden, and the insulated position of the Lake Mountains are at once explained.

Lastly. The author speculates on the origin of the phænomena described, and points to the different crystalline rocks appearing near the carboniferous chain. He proves that the great breaks took place immediately before the oldest deposits of the new red sandstone, and endeavours to show that they were produced by a violent transitory, and not by a long-continued action.

Jan. 19.—Robert Trotter, Esq. of Borde Hill, Cuckfield, Sussex; and Thomas Hodgson Holdsworth, Esq. of Gray's Inn Square, were elected Fellows of this Society.

The reading of a paper, entitled "Supplementary Observations on the Structure of the Austrian and Bavarian Alps," by Roderick Impey Murchison, Esq. Sec. G.S. F.R.S. was begun.

Feb. 2.—Robert Francis Seale, Esq. Secretary to the Governor of St. Helena, was elected a Fellow of this Society.

The reading of the paper, by Roderick Impey Murchison, Esq. Sec. G.S. F.R.S., begun at the last Meeting, was concluded.

This memoir contains the results of observations made by the author during last summer, with the view of extending the researches of Professor Sedgwick and himself\*: the present remarks being limited to the consideration of that portion of the Alps, on the northern side of the axis, which is included between the lake of Constance on the west, and Vienna on the east, followed by a short description of the valley of the Danube.

1. *Primary Rocks*.—He notices that Mr. Partsch and himself discovered that traces of the primary axis of the Alps reappear in the Leitha-gebirge, and are there overlaid on each side by tertiary deposits.

2. *Transition Rocks with Iron Ores* are briefly alluded to, merely for the purpose of marking their place in the series.

3. *Rauchwacke or Magnesian Limestone*.—The author shows that the formation is better developed near the eastern termination of the Austrian Alps, (St. Johann, Kirchbüchel, Söbenstein, &c.) that it there dips under red sandstone and Alpine limestone, and is quite similar to rocks occupying the same position in the Tyrol (Schwatz, Söll, &c.).

4. *New Red Sandstone with Salt and Gypsum*.—In former sections, (published by Professor Sedgwick and the author,) this formation is only designated in one line of valleys, i. e. along the great escarpment of the Alpine limestone; recent observations have, however, convinced the author, that it is reproduced in other longitudinal depressions, further removed from the axis of the chain. In the valley of Abtenau, for instance, he ascertained that the red sandstone containing thick masses of gypsum and several salt-springs, dips conformably on one side under black shale and limestone, of the age of the lias, and on the other is overlaid unconformably by the shelly deposits of Gosau. He also cites Berchtesgaden, with its salt-mines, as another case of a valley in which the new red-sandstone is denuded, and he shows that the strata there dip beneath the whole of the oolitic series of the Kneifelberg and Untersberg.

5. *Lower Alpine Limestone, or Lias and Inferior Oolite*.—It is stated that the dark-coloured limestone and shale which surmount the red sandstone at Abtenau, range northwards with various contortions, and are well exposed in the gorge of the Mertelbach below Crispel; where, accompanied by M. Von Lill, the author collected several fossils, viz.: Ammonites, two species, (one very near to *A. Conybeari*,) Pecten, three species, small Gryphæa, Mya,

\* One of Prof. Sedgwick and Mr. Murchison's papers on the Austrian Alps, here alluded to, will be found in the *Philosophical Magazine and Annals*, vol. viii. p. 81. See also the Proceedings of the Geological Society, pp. 153, 227.

*Perna*, two species, *Ostræa*, *Corallines*, &c. In mineral characters these beds, it is said, closely resemble some of those of Whitby, from which, together with the complexion of the fossils, and their place in the series, the author refers the group to the lias. An overlying red, encrinite limestone, contains at least five or six species of *Ammonites* and some *Belemnites*; amongst the former is the *A. multicosatus*. This red limestone crops out on both sides of the valley of the Salza near Hallein, and reappears in various places in the Salzburg Alps (*Aussee*, *Ebensee*, &c.).

6. *Salt Deposits*.—The place assigned to most of the salt-mines of the Austrian Alps in the memoir of last year, has been confirmed; and additional sections are given at Halstadt and Aussee to prove that the salt masses in these places are fairly encased in Alpine limestone. In other localities, however, as above indicated, this mineral is shown to occur in the same formations as in England.

7. *Upper Alpine Limestone, or Upper Oolite*.—In this group the author comprehends semi-crystalline, brecciated, scaly, compact and dolomitic limestones. The Hippurite limestone, though with some doubt, is considered to mark the superior limit of the series, the author having been led to this conclusion from the relations seen on the north flank of the Untersberg, at Windischgarsten, Gosau and the Wand, in all of which places there are passages from the Alpine limestone into the Hippurite rock.

8. *Sandstone, Calcareous Grit and Shales, Slaty Limestone, &c.*—The *Grès de Vienne* is placed by the author as the lowest member of this group; although in the eastern termination of the Alps he agrees with M. Boué, that its separation from the Alpine limestone cannot well be effected. All along the chain, however, from the Enns to the lake of Constance, he thinks that the grits and shales with fucoids constitute a natural group distinguished in external characters from the Alpine limestone, and that they there form the lowest term of the green sand. He then describes several transverse, parallel sections across that zone. The first of these is in the valley of the Allgau or Sonthofen, in the upper end of which, near Mieselsstein, the grits and fucoid shales are broken through by gneiss, which appears to have been heaved up in a solid form posterior to the deposition of the former; whilst in an adjoining gorge dikes of igneous rocks seem to have made unavailing efforts to pierce through the overlying mountain of the Schwarzenberg. The dislocations and inversions of dip in the parallel ridges of the Allgau are described in detailed sections. At the mouth of the valley, the Grinten, a narrow serrated mountain, ranging E.N.E. and W.N.W., is composed of many of the same rocks described last year at Nesselwang, but owing to a complete reversal of dip the lowest beds or inferior green sand are thrown into juxtaposition with a ridge of conglomerate of tertiary age, which dips to the north beneath the molasse of the plain. The lowest beds are nearly vertical, and consist of brown chert; these are succeeded by green, calcareous sandstone and grit highly inclined, containing *Inoceramus concentri-*

*cus*, *Mya plicata*, *Plicatula pectinoides*, a small *Gryphæa*, Ammonites and Belemnites,—fossils characteristic of the middle and lower green sand. The overlying strata are a cream-coloured limestone with Ammonites, passing up into a slaty, red, marly, limestone undistinguishable from *Scaglia*. The formations seen in the Grinten, therefore, are a part of the lower, all the upper green sand, and probably a portion of the chalk.

9. *Lower Nummulitic Limestone and Shale, &c. (Sonthofen Iron Ores).*—The strata containing the iron ores at Sonthofen surmount the preceding series in the gorge of the Starzlach. The author considers them, from the character of their fossils, particularly *Spatang*i, certain species of Nummulites, Belemnites, *Terebratulæ*, and *Trigonæ*, to be more connected with the cretaceous than with the superior formations. To show the essential difference between the age of these iron ores of Sonthofen and those of the Kressenberg, a detailed section is described from south to north on the banks of the Traun, where a vast thickness of lower, nummulitic, calcareous grit, with shales, marls, and cretaceous beds (as exhibited in vertical strata opposite the town of Arzt), are shown to be of the same age as those of Sonthofen, and are clearly proved to be overlaid by the nummulitic iron ores of the Kressenberg.

10. *Upper Nummulitic Iron Ores.*—It is to the shelly iron ores at Kressenberg, and not to those of Sonthofen, that Professor Sedgwick and the author assigned the place of *transition-tertiary* beds,—a place, the correctness of which, it is contended, is now established as clearly by the evidences of superposition, given in this memoir, as it formerly was by Count Münster, from the vast predominance of tertiary fossils.

The natural section on the Traun is then completed, by showing that the *transition-tertiary* beds are conformably overlaid by inclined strata of pebbly sandstone and marls, in the higher part of which, near Traunstein, there are a number of shells unquestionably of tertiary age. All these inclined strata are capped by a thick range of horizontal coarse conglomerate. Sections made on the flanks of the Untersberg confirm the observations of the previous year, and show the Hippurite limestone dipping under the green sand and shale,—the green sand and cretaceous beds surmounted by a vast thickness of nummulitic, green grit; and this again overlaid by blue marls with shells of the age of Gosau and Kressenberg\*.

Other localities are noticed, where detached remnants of both the lower and upper nummulitic groups were visited by the author, (St. Pancratz, Mattsee, &c.), and the *Gryphite* abounding in these beds is stated to be *not* the *Gryphæa columba*, but a new species. Through the labours of Mr. Lonsdale, eight species at least of

\* This section as given last year (*Phil. Mag.* vol. viii. pl. 2. fig. 1.) necessarily terminated in ascending order with the river Saal, because the Högl on its northern bank consists of secondary grit and shale (green sand), which being thrown off from the Stauffen, a promontory of Alpine limestone, abuts unconformably against the tertiary strata described.

Nummulites have been distinguished, some of which characterize the lower or secondary strata at Sonthofen, Arzt, and Mattsee, others together with a coral (*Nummulina complanata*) prevail in the *transition-tertiary* groups of Kressenberg, Schweiger Mill, &c. Having thus, both by superposition and by fossils, shown the existence on the flanks of the chain of a deposit with a predominance of tertiary and very few secondary shells, as distinguished from a lower group in which secondary fossils prevail, the author proceeds to point out accumulations of the same age, at various heights, within the great secondary chain of the Alps.

In the valley of Gosau several new facts are enumerated. The edges of the shelly deposit are seen to rest on red sandstone, on Alpine and Hippurite limestone, and on green sand. Besides the underlying conglomerate\*, the shelly system is considered to be clearly divisible into two parts, of which the inferior contains many secondary as well as tertiary fossils, with Tornatella (*Turbinellus*, Sow.), Nerinea, rolled Hippurites, &c.; whilst the superior blue marls abound with myriads of shells of a tertiary aspect, and many corals, of species figured by Goldfuss, from the tertiary formations at Castel Arquato, Bassano, &c.

As all the conchologists who have seen the unmixed shells of these upper blue marls have declared that they belong to formations newer than the chalk, the author conceives this case, therefore, to be now established beyond dispute, both by stratigraphical and zoological evidence: and he further is of opinion that the slaty overlying psammites of the Horn and the Ressenberg clearly represent the molasse.

A case of more extraordinary elevation than that of Gosau was this year discovered by the author, in the Alpine pasturage of Zlam above Aussee and Grundelsee, where blue marls with Cerithia, sharks' teeth, &c., overlie calcareous grits and conglomerate, with Tornatella and Nerinea, and are carried up in a cleft of Alpine limestone to at least 6000 feet above the sea. Several localities mentioned by Dr. Boué are then alluded to: Windischgarsten is a valley similar to Gosau, of which, according to the author, it exhibits only the lower shelly beds, and amongst the contiguous rocks on which these repose, are grits, fucoid shales, Hippurite limestone, younger Alpine limestone, &c.

Formations of the *transition-tertiary* age are then described on three sides of the Wand, a mountain of Alpine limestone at the eastern extremity of the Alps, where the author made various sections assisted by Mr. Partsch of Vienna. At Piesting Meyersdorf, Dreystetten and Grünbach, they found that the shelly, blue marls invariably occupied the same place in the series as at Gosau. At Grünbach, the ascending order, as seen in vertical strata, is Alpine and Hippurite limestones, green grit and shale, coal beds with freshwater shells, nummulitic grit, marls with Gosau shells and corals. In none of these sections could Mr. Partsch or the author

\* See former Memoir, Proceedings of Geological Society, p. 154.

detect the trace of Belemnites, said to have been found here by Dr. Boué.

II. *The memoir next describes the valley of the Danube.*

It is stated that the phenomena on the flank of the Bohemian chain, even where it approaches very near to the Alps, are entirely different from any that have been previously described.

In a section from Vilshofen, on the Danube, to Schaerding, true chalk with flints and characteristic fossils is seen, at Ortenburg, resting horizontally on black granite. The surface of this chalk is corroded, and the fissures are filled and covered by sands with oysters, and these again by blue marl, all wearing the aspect of the lower tertiaries in England. These beds in the Inn-kreis, at Pielach near Mölk, &c. &c. stretch *horizontally* round promontories of gneiss and granite, and offer a remarkable contrast to the *verticality* and dislocations of the strata of the same age in the opposite and principal chain of the Alps.

These discrepancies of arrangement, when coupled with the differences in the direction of the two chains, are cited as corroborating some of the views of M. Elie de Beaumont: for the Bohemian mountains trending from N.W. to S.E. are seen not to have been moved from a very ancient period; whilst the principal chain of the Alps running from W.S.W. to E.N.E. is found to have undergone one of its last convulsions posterior to some of the most recent accumulations.

The tertiary deposits in the valley of the Danube and basin of Vienna are cursorily enumerated. At Pielach and other places near Mölk, the lower blue marl or *Tegel* alternates with, and is surmounted by, yellow sand; and the lowest beds of this system are presumed to be the equivalents of the London clay and lower Subapennines.

The middle and higher tertiary deposits are alone well seen in the basin of Vienna, and this the author attributes to the gradual declension in the height of the Alps in their range to the east, by which the older tertiaries, which rest on their edges, are not brought to day in that neighbourhood. These lower beds have, however, been reached by borings near Vienna, where 300 feet of the inferior blue *Tegel* have been traversed, even to the white sands. The lower blue marl is covered by yellow sand containing many species of shells, and this again passes up into upper blue marl.

It is from these upper sands and marls, although of not half the thickness of the lower, that nearly all the known shells of the basin of Vienna have hitherto been collected; and hence the author infers that it is impossible to decide upon the comparative age of all the formations in this basin until the species of the different deposits be separately ascertained,—a work which he hopes to see accomplished by M. Partsch.

The blue marls and sands are proved to be overlaid by a pebbly, calcareous conglomerate, which graduates upwards into the *Leitha-Kalk* or great, white, coralline building-stone of Vienna, containing bones of Tapir, Mastodon, &c. (Loretto, Margarethen, Eisenstadt,



Wöllersdorf); and this rock is identified, by the author, with the coral limestone of Lower Styria, formerly described by Prof. Sedgwick, and himself.

It is stated that freshwater limestone, with *Lymnæa*, *Helix*, and *Planorbis*, is seen in patches (Eich Kogel, &c.), but that where this formation is absent, the *Leitha-Kalk* is usually succeeded by thick accumulations of gravel and sand, with concretions, and bones of Tapir, Mastodon, Anthracotherium, &c.; these gravel beds being of the same age with the superior deposits of Lower Styria, through which it has been asserted in a former memoir, that basaltic and trachytic eruptions have penetrated\*.

Lastly. The superficial covering of the low countries of Austria, called *Löss*, is mentioned as being of great thickness and extent, containing bones of extinct species of elephants, mixed up with terrestrial shells of existing species, which character, combined with its loamy structure, is considered to indicate a tranquil period of deposit.

Recapitulating the principal points illustrated in this memoir, the author recurs to that essential part of it, in which, following up the idea of Prof. Sedgwick and himself, he endeavours to prove the large development and persistence in the eastern Alps of certain shelly deposits, of an age intermediate between the chalk and the tertiary formations; and he concludes by expressing an opinion, that with more extended examination, geologists may arrive at the conclusion, that the disturbing forces which in the West of Europe have destroyed the formations succeeding to the chalk, were local phenomena, which operated through a limited portion only of the earth's surface.

Feb. 16.—John Evans, Esq. of Hertford-street, May Fair; John McDonnell, Esq. of Upper Gloucester-place; James C. Somerville, Jun. M.D. of Princes-street; and John Badams, Esq. of Birmingham, were elected Fellows of this Society.

A letter was first read from Peter Cunningham, Esq. dated Newcastle on Hunter's River, New South Wales, Oct. 16, 1829; and communicated by John Barrōw, Esq. F.R.S. &c.

This letter is written with a view to give some insight into the former state of the interior of New South Wales, and the writer accompanies it with a few organic remains; amongst others, with the second cervical vertebra of a large animal, found on the surface. He states, that a great ridge separates the eastern and western waters, running from N.N.E. to S.S.W. and that in Liverpool Plains the oldest rock appeared to be a hard, blue granite with red sandstone on its flanks. Granite has also been seen at the Wallanbai rivulet, at Carrington, and at Waybong,—distances of 35, 55, and 100 miles from the sea. In the Liverpool range, it is said, there is a slaty, blue rock resembling grauwacké, and that this is succeeded, about 26 miles up the Patterson, by a coarse, red sandstone, and that again by a blue limestone. Another limestone is described as having an oolitic structure with corals on its

\* Proceedings of Geological Society, p. 213.

surface. Most of the alluvial tracts in this part of the colony (Liverpool Plains, &c.) are spoken of as consisting of rich, black, loose mould, formed by depositions from the hills, which on the slopes arrays itself into ridges, and in the plains into alternate hillocks and cavities.

Much red sandstone with salt springs is stated to exist in the interior, as well as on the coast of the colony, and the red, loose, sandy soil is said to be generally covered with the "iron tree", and with long, weak spikes of flaccid grass. It is to the want of an admixture of clay, or any retentive stratum, with the sands, that the author attributes the great deficiency of water in the colony, boring having been found quite useless throughout the absorbent sandstone country, although in the immediate flanks of the primary ridges water gushes out freely, and chalybeate and saline springs occur at short distances from each other.

The coal of the colony appears to be a lignite, and is associated with grey marlstone containing impressions of leaves of dicotyledonous plants. The secondary rocks contain casts of *Terebratulæ* and other shells; but the author does not attempt to make out precisely the order of superposition, or the equivalents of the strata.

A memoir was then read "On the Geology of the Island of Juan Fernandez, in the Pacific Ocean, by Alex. Caldcleugh, Esq. F.G.S."

After a sketch of the past history and present state of this island, celebrated as the place of exile of Alexander Selkirk, the author proceeds to state that it is about twelve miles in length and four in breadth, possessing three ports, and consisting of very high land, the culminating point of which rises to about 3005 feet above the sea.

The author could discover no trace of a volcano said to exist here by former visitors; all the rocks, according to him, consist of basaltic greenstone and trap of various mineralogical structure, both amorphous and vesicular, together with trappean concretions, no other contained minerals being observable except olivine and *chaux carbonatée métastatique*. It is further mentioned that the basalt in parts is almost columnar, and in others has a peaked and serrated outline, the mass being, here and there, traversed by dykes.

Owing to the peculiar character of this basalt, and especially from the great quantity of olivine, the author compares its age with that of the basalt of Bohemia, the Rhine, the Vivarrais, and Beaulieu in Provence.

After the ordinary business of the evening had been concluded, a Special General Meeting was held, when it was unanimously resolved, that the Session should terminate, for the future, on the first evening of Meeting in June.

PROCEEDINGS  
OF  
THE GEOLOGICAL SOCIETY OF LONDON.

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1831.

No. 20.

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AT THE

*ANNUAL GENERAL MEETING,*

*18th February 1831,*

The following Report from the Council was read :—

The Council, in making their Annual Report, feel great pleasure in being able to present a series of Returns, by which the continued prosperity of the Society, and its increasing interest in public opinion, are clearly proved.

The Council beg, in the first place, to call the attention of the Society to the Report of a Select Committee, appointed to examine the state of the Museums and Library ; by which it will be seen that many important additions were made during the past year.

It is with great satisfaction that the Council call attention to the Treasurer's Reports. On referring to these documents it will be seen that the estimated Receipts for the ensuing year exceed the estimated Expenditure, including the cost of the publication of a new Part of the Society's Transactions.

By the returns connected with the numerical strength of the Society, the Council have the satisfaction of showing, that the loss by deaths and resignations during the past year amounted to only Six while the accession of new Fellows amounted to Fifty-one ; making an actual increase on the Books of the Society of Forty-five.

The Council, ever anxious to promote the circulation of the Society's Transactions, have directed much of their attention since the last anniversary to this important subject ; and they have made arrangements with Messrs. Treuttel and Würtz, by which they hope that the hitherto accumulating stock will be speedily reduced, and the knowledge of the Transactions themselves be widely diffused both at home and abroad.

Finally, the Council are anxious to concur in the sentiments expressed in the concluding sentence of the Report on the state of the Museum, and to record their testimony of the great talents and self-devotion manifested by Mr. Lonsdale ever since his first connection with the Society.

Report upon the Museums and Library.

I. ENGLISH COLLECTION. The additions to this part of the collection consist of bones of *Elephas Primigenius*, of Rhinoceros and other

bones usually found in the gravel, presented by Mr. Hobson; and of bones of *Palæotherium*, *Anoplotherium*, and of a new species of Deer from Binstead in the Isle of Wight, presented by S. P. Pratt, Esq. The valuable collection from the green-sand and Wealden formation illustrative of all the beds between the chalk and the Portland stone, presented by Dr. Fitton, will render complete a most interesting portion of the series.

II. THE FOREIGN COLLECTION. This has been greatly enriched. In addition to the elephant's tusks from the frozen mud in the cliffs of Eschscholtz Bay, brought home by Captain Beechey, R.N. and presented by the Lords of the Admiralty, Captain Belcher, R.N. has given the specimens obtained by him during the late expedition under the command of Captain Beechey, and illustrative of the geological memoir in the Appendix to the Voyage published by the last-mentioned officer, drawn up by Dr. Buckland from the notes of Captain Belcher and Mr. Colley. To the Philadelphia Museum Company the collection is indebted for some fine bones of *Mastodon angustidens*? brought home by Captain Basil Hall, R.N.:—to Woodbine Parish, Esq. for bones of a *Mastodon* from Buenos Ayres:—to Professor Von Dechen for a collection of Rocks from the Siebengebirge:—and to Dr. Fitton for a very important collection illustrative of his Memoir on part of the Low Countries and the north of France, principally near Maestricht and Aix la Chapelle.

In the arrangement of this collection great progress has been made since the last Report. The specimens, illustrative of all the European countries north of the Rhine—a portion of those illustrative of Asia, (viz. those of all China and of a part of India)—and the whole African, American and Australian collections are completely arranged and partly labelled.

III. SIMPLE MINERALS. Some additions have been made to this part of the collection, which has been entirely re-arranged, and the Curator has prepared an alphabetical catalogue of the specimens.

IV. LIBRARY. The number of Books and Maps is considerably increased; but the Committee regret to observe the deficiency of works of reference, especially of the more modern publications illustrative of Fossil Zoology and Botany. The geological map of Styria laid down under the immediate superintendence of the Archduke John of Austria is so well executed, that the Committee cannot forbear calling the attention of the Society to this useful present from His Imperial Highness.

The Committee, in conclusion, feel it their duty to express their entire approbation of the results of the great zeal and talent manifested by the Curator since the last Report; and they beg to state their conviction, that to the willing devotion of his time and ability the Society owes no small part of the advancing prosperity of the department submitted to his care.

*Geological Society,*  
Feb. 2, 1831.

W. J. BRODERIP.  
EDWARD TURNER.  
H. T. DE LA BECHE.

Comparative Statement of the number of the Society, at the close of the years 1829—30.

Fellows.	31st Dec. 1829.	31st Dec. 1830.
Having compounded.....	56.....	59
Contributing.....	164.....	177
Non-residents .....	243.....	272
	<hr/> 463	<hr/> 508
Honorary .....	51.....	50
Foreign Members .....	55.....	56
Personages of Royal Blood .....	3.....	3
	<hr/> Total 572	<hr/> 617

*The following Persons were elected Fellows and Foreign Member during the year 1830.*

January 1st.—Rev. Henry Coddington, of Trinity College, Cambridge.

January 15th.—William Parker, Esq. Albany Street, Regent's Park ; and the Rev. Henry Parr Hamilton of Trinity College, Cambridge.

February 5th.—James Calder, Esq. of Calcutta ; and Edward Johnstone, Esq. of Trinity College, Cambridge.

March 5th.—Richard Smith, Esq. of Connaught Square ; Sir Thomas Maryon Wilson, Bart. of Charlton House, Kent ; Aristides Franklin Mornay, Esq. of Ashburton House, Putney ; the Rev. Counop Thirlwall of Trinity College, Cambridge ; the Rev J. Philip Higman of Trinity College, Cambridge ; and William Parry Richards, Esq. of Queen Street, Bloomsbury.

March 19th.—Henry Rowland Brandreth, Esq. of the Royal Engineers, Woolwich ; Sir Thomas Phillips, Bart, of Middle Hill, Worcestershire ; and Robert Alfred Cloyne Austen, Esq. of Lincoln's Inn, London.

April 2nd.—William Hallows Miller, Esq. of St. John's College, Cambridge ; Lloyd Baker, jun. Esq. of Hardwicke, Gloucestershire ; William Grenville Eliot, Esq. of Hastings ; the Rev. Henry Engleheart of Caius College, Cambridge ; Josias Lambert, Esq. of Liverpool Street, London ; and Thomas Morgan, Esq. of Thames Ditton, Middlesex.

April 16th.—John Rennie, Esq. and George Rennie, Esq. of Whitehall Place ; Alfred Thomas, Esq. of Haverfordwest, Pembrokeshire ; Charles Mundy, jun. Esq. of Burton Hall, Loughborough ; and Alexander Turnbull Christie, M.D

May 7th.—Thomas England, Esq. of Pembroke College, Cambridge ; Howard Elphinstone, Esq. of Pembroke College, Cambridge ; and Robert Edmond Grant, M.D. of the London University.

May 21.—Granville Lonsdale, Esq. of the Third Regt. of Foot.

June 4th.—Rev. Richard Dawes, Fellow of Downing College, Cambridge ; the Rev. Charles Currie, of Pembroke College, Cam-

bridge; the Rev. Thomas Musgrave, Fellow of Trinity College, Cambridge; William Devonshire Saull, Esq. of Aldersgate Street, London; and Francis Ellis, Esq. of the Royal Crescent, Bath.

June 18th.—Robert Dawson, Esq. of the Royal Engineers.

November 3rd.—The Rev. Thomas Boyles Murray of Hart Street, Crutched Friars; James Edward Winterbottom, Esq. of Southampton Buildings; William Taylor, Esq. of Canonbury Square; Charles Shaw Lefevre, Esq. of Whitehall Place; the Rev. Thomas Arnold, D.D. Head Master of Rugby School; Henry Ellis, Esq. of Welbeck Street; the Right Honourable the Earl of Selkirk; and William Joseph Bayne, M.D. of Trinity College, Cambridge.

November 17th.—The Rev. William Kirby of Barham, Norfolk; John Prideaux Selby, Esq. of Twizell House, near Belford, Northumberland; and James Dickson, Esq. of Kidbrooke, Blackheath.

December 1st.—The Rev. Daniel Petteward, of One-House, near Stowmarket; and John William Bowden, Esq. of Trinity College, Oxford.

December 15th.—The Rev. Willam Turner of Trinity College, Cambridge, and Christ Church, Oxford; Anthony Todd Thompson, M.D. of the London University; and George Townsend Fox, Esq. of Westhoe, Durham.

*Foreign Member, elected in 1830, Count Munster, of Bayreuth.*

The Names of the Fellows deceased, within the past year, are as follow :—

Compounders .....	(None.)
Residents .....	Henry Hakewill, Esq.
Non-residents .....	{ Thomas James Bosville, Esq. Richard Chenevix, Esq.
Foreign .....	
Honorary .....	(None.)
	Dr. James Miller.

The MUSEUM has received many donations since the last Anniversary, among which are included the following :—

*British and Irish Specimens.*

Portions of four basaltic columns from the Giant's Causeway; presented by Henry Habberley Price, Esq. F.G.S.

Fossils from the Green-sand, Lias, and Carboniferous Limestone; presented by Henry Humphrey Goodhall, Esq. F.G.S.

Specimens from the Coal Basin of South Wales; presented by Josias Lambert, Esq. F.G.S.

Two specimens of *Rostellaria macroptera*; presented by the Rev. John Ward, F.G.S.

A collection of Fossils from the Mountain Limestone of Devonshire; presented by Henry Thomas De la Beche, Esq. F.G.S. F.R.S. &c.

Fossils from the Lias and Oolitic Coal Measures of Yorkshire; presented by Nicholas Dennys, Esq. F.G.S.

- Specimens of the fossil plant from Wideopen ; presented by William Hutton, Esq. F.G.S.
- Horns of Deer from the neighbourhood of the London Docks ; presented by H. R. Palmer, Esq.
- Specimens from a brick-field and the gravel near Colchester ; presented by J. Brown, Esq.
- A collection of Fossils from the neighbourhood of Farley Hungerford ; presented by the Rev. Benjamin Richardson, Hon. Mem. G.S.
- Fossils from the Isle of Wight ; presented by John Willimott, Esq. F.G.S.
- Remains of the Palæotherium, Anoplotherium, and a new variety of Deer and Turtle, from Binstead in the Isle of Wight ; presented by Samuel Peace Pratt, Esq. F.G.S. F.L.S.
- Several new Fossils from the Crag ; presented by Samuel Woodward, Esq.
- Remains of the Elephant, Rhinoceros, Horse, and Ox, from Kingsland ; presented by William Hobson, Esq. F.G.S.
- Vegetable remains from the South-Staffordshire Coal Field, and a collection of Geological specimens ; presented by the Rev. James Yates, F.G.S. F.L.S.
- Fossils from Milton, Yorkshire ; presented by Edward Spencer, Esq. F.G.S.
- Dapedium politum, and other Fossils, from Lyme Regis ; presented by Roderick Impey Murchison, Esq. Sec. G.S. F.R.S. &c.
- Specimens of Lignite from Bovey Tracey, and Minerals from Haytor Mine ; presented by Thomas Hodgson Holdsworth, Esq. F.G.S.

*Foreign Specimens.*

- Tusks of an Elephant from the frozen mud in the Cliffs of Eschscholtz Bay, brought home by Capt. Beechey, R.N. ; presented by the Lords of the Admiralty.
- A collection of specimens from Australia ; presented by the Venerable Archdeacon Scott, F.G.S.
- A series of Geological specimens collected by Captain Belcher during the expedition to Behring's Straits, under the command of Captain Beechey, R.N. ; presented by Captain Belcher, R.N. F.G.S.
- Native Platina, and native alloy of Iridium and Osmium ; presented by Thomas Johnson, Esq. F.G.S.
- A collection of bones of the Mastodon ; and specimens of rocks and simple minerals from North America ; presented by the Philadelphia Museum Company, and brought to England by Captain Basil Hall, R.N. F.G.S. F.R.S. &c.
- Geological specimens from the South of Spain ; presented by Colonel Charles Silvertop, F.G.S.
- Two species of recent Tree Ferns from Jamaica ; presented by Henry Thomas De la Beche, Esq. F.G.S. F.R.S.
- A collection of rocks from the Siebengebirge ; presented by Professor Von Dechen of Berlin, For. Mem. G.S.
- Geological Specimens from Nova-Scotia and New Brunswick ; presented by Dr. Ridgway.

- Collections of Rocks and Fossils from Maestricht, Aix-la-Chapelle, &c. ; presented by William Henry Fitton, M.D. F.G.S. F.R.S. &c.  
 Remains of the Mastodon found at Salta, in Buenos Ayres ; presented by Woodbine Parish, Esq. His Majesty's Chargé d'Affaires, and Consul General at Buenos Ayres.  
 Geological specimens from the Isle of Ascension ; presented by Lieut. Fayrer, R.N.  
 A collection of rocks from the neighbourhood of Guanaxuato ; presented by Edward Hurry, Esq.  
 Specimens from the Island of Ascension ; presented by Charles Lyell, Esq. For. Sec. G.S. F.R.S.  
 Specimens from the Isthmus of Darien ; presented by John Augustus Lloyd, Esq. F.R.S.  
 Specimens of silicate of copper, sulphate of barytes containing native silver, limestone, and fossils from Coquimbo, in Chili ; and a series of geological specimens from the Bay of Conception ; presented Alexander Caldcleugh, Esq. F.G.S.  
 A collection of Rocks and Fossils, from Hunter's River, New South Wales, collected by Peter Cunningham, Esq., and presented by John Barrow, Esq. F.R.S.  
 Specimens from the Valleys of the Araja and Terek, in the Caucasus ; presented by Lieut. Col. Monteith.

The LIBRARY has been increased by the donation of 70 volumes and pamphlets.

The Second Part of the Third Volume of the New Series of the Transactions has been put to press, and it is hoped that it will be published early in the ensuing summer.

The following LIST contains the NAMES of all the Persons and Societies from whom Donations to the Library and Museum have been received during the past year.

Ainsworth, William, Esq.	Broderip, William John, Esq.
American Philosophical Society,	V.P.G.S. F.R.S.
Philadelphia.	Brown, John, Esq.
Asiatic Society of Calcutta.	
Royal Asiatic Society of Great	Caldcleugh, Alexander, Esq.
Britain.	F.G.S.
	Cambridge Philosophical Society.
Baddeley, F. H. Esq. Lieutenant	Caumont, M. de.
Roy. Eng.	Cheek, Henry, H. Esq.
Barrow, John, Esq. F.R.S.	Chevalier, Mons.
Beaumont, M. Elie de, For. Mem.	Clarke, James, M.D.
G. S.	
Belcher, Edward, Esq. Capt. R.N.	Dechen, Henreich von, For. Mem.
F.G.S.	G.S.
Boué, Dr. Ami, For. Mem. G.S.	De la Beche, Henry Thomas,
Brookes, Joshua, Esq. F.R.S.	Esq. F.G.S. F.R.S.



Dennys, Nicholas, Esq. F.G.S.  
Dufrénoy, Mons. For. Mem. G.S.

East India Company, the Hon.  
the Board of Directors.

Egerton, Sir Philip de Malpas  
Grey, Bart. M.P. F.G.S. F.R.S.  
Esmark, Professor, For. Mem. G.S.

Fayrer, Lieut. R.N.  
Fischer, Gotthelf, For. Mem. G.S.  
Fitton, William Henry, M.D.  
F.G.S. F.R.S.  
Frazer's Magazine, Editor of.

Geological Society of France.  
Godman, John, M.D.  
Goodhall, Henry Humphrey, Esq.  
F.G.S.

Hall, Capt. Basil, R.N. F.G.S.  
F.R.S.  
Hansteen, Professor.  
Hardwicke, Major General.  
Hays, Isaac, M.D.  
Heathfield, Richard, jun. Esq.  
F.G.S.

His Imperial Highness The Arch-  
duke John of Austria, For. Fel-  
low G.S.

Hœninghaus, F.W.  
Hoff, Karl Ernest Adolf von.  
Hogg, I. Esq. F.L.S.  
Hobson, William, Esq. F.G.S.  
Holdsworth, Thomas Hodgson,  
Esq. F.G.S.

Henry, Edward, Esq.  
Hurry, Edward, Esq.  
Hutton, William, Esq. F.G.S.

Johnson, Thomas, Esq. F.G.S.  
Joubert, Mons.

Kleinschrod, Mons.  
Klipstein, Dr. A.

Lambert, Josias, Esq. F.G.S.  
Lea, Isaac, Esq.  
Leeds Philosophical Society.  
Lilienbach, Mons. Lill von.  
Lindley, John, Esq. F.G.S. F.R.S.

Linnæan Society.  
Literary and Historical Society of  
Quebec.

Lloyd, John Augustus, Esq.  
F.R.S.

London Institution.  
Loudon, John, Esq. F.G.S.

Lyell, Charles, Esq. For. Sec.  
G.S. F.R.S.

Medico-Botanical Society.  
Monteith, Lieut. Col.  
Murchison, Mrs.  
Murchison, Roderick Impey, Esq.  
Sec. G.S. F.R.S.

Palmer, H. R. Esq.  
Parish, Woodbine, Esq. His  
Majesty's Chargé d'Affaires at  
Buenos Ayres.

Plymouth Institution.  
Pratt, Samuel Peace, Esq. F.G.S.  
F.L.S.

Price, Henry Habberley, Esq.  
F.G.S.

Richardson, Rev. Benjamin, Hon.  
M.G.S.

Ridgway, Dr. F.L.S.  
Robnet, Mons.

Royal Astronomical Society.  
Royal Academy of Sciences, Paris.  
Royal College of Surgeons.  
Royal Institution.

Royal Irish Academy.  
Royal Geological Society of Corn-  
wall.

Rozet, Mons.

Savi, Professor.  
Scott, the Venerable Archdeacon,  
F.G.S.

Sedgwick, Rev. Professor, Pres.  
G.S. F.R.S.

Silliman, Professor, M. D. For.  
Mem. G.S.

Silvertop, Col. Charles, F.G.S.  
Society of Arts.

Spencer, Edward, Esq. F.G.S.  
Stanley, Rev. Edward.

Sturtz, Mons.

Taylor, Richard, Esq. F.G.S. Sec. L.S.	Woodward, Samuel, Es .
Taylor, Richard Cowling, Esq. F.G.S.	Witham, Henry, Esq. Hon. Mem. G.S.
Thomas, Alfred, Esq. F.G.S.	White, Henry Campbell, Esq. F.G.S.
Thorpe, Thomas, Esq.	Willimott, John, Esq. F.G.S.
Turner, Edward, M.D. F.G.S. F.R.S.L. & E.	Winch, Nathaniel J., Esq. Hon. Mem. G.S.
Voltz, M. For. Mem. G.S.	Yates, Rev. James, F.G.S. F.L.S. Yorkshire Philosophical Society.
Warburton, Henry, Esq. M. P. F.G.S. F.R.S.	Zimmerman, Dr. Zoological Society.
Ward, Rev. John, F.G.S.	

*List of PAPERS read since the last Annual Meeting, Feb. 19, 1830.*

- March 5.—On the Tertiary Deposits of Lower Styria ; by the Rev. Adam Sedgwick, Pres. G.S. F.R.S., Woodwardian Professor in the University of Cambridge, &c., and Roderick Impey Murchison, Esq. Sec. G.S. F.R.S. &c.
- March 19.—Reference to a Geological Map and Section of Pembroke-shire ; by Alfred Thomas, Esq. F.G.S.
- The first of two Letters addressed to Roderick Impey Murchison, Esq. Sec. G.S. on the Lacustrine Basins of Baza and Alhama, in the Province of Grenada, and similar deposits in other parts of Spain ; by Col. Charles Silvertop, F.G.S.
- April 2 and 16.—On the Geology of Weymouth and the neighbouring coasts of Dorsetshire ; by the Rev. William Buckland, D.D. F.G.S. F.R.S. Professor of Geology and Mineralogy in the University of Oxford, &c. and Henry Thomas De la Beche, Esq. F.G.S. F.R.S. &c.
- April 16.—Description of a new species of Ichthyosaurus ; by Daniel Sharpe, Esq. F.G.S.
- May 7.—Sketches explanatory of a Geological Map of the Archduchy of Austria and of the South of Bavaria ; by Dr. Ami Boué, For. Mem. G.S. &c.
- May 21.—Sketch of the Structure of the Austrian Alps ; by the Rev. Adam Sedgwick, Pres. G.S. F.R.S., Woodwardian Professor in the University of Cambridge, &c., and Roderick Impey Murchison, Esq. Sec. G.S. F.R.S. &c.
- June 4.—On the Geological Relations of the South of Ireland ; by Thomas Weaver, Esq. F.G.S. F.R.S. M.R.I.A. &c.
- June 18.—The second of two Letters addressed to Roderick Impey Murchison, Esq. Sec. G.S. on the Lacustrine Basins of Baza and Alhama, and similar deposits in other parts of Spain ; by Col. Charles Silvertop, F.G.S.
- November 3 and 17.—Remarks on the Formation of Alluvial Deposits ; by the Rev. James Yates, F.G.S. F.L.S. &c.
- December 1.—An explanatory sketch of a Geological Map of Mo-

ravia and the West of Hungary ; by Dr. Ami Boué For. Mem. G.S. &c.

December 15.—An explanatory sketch of a Geological Map of Transylvania ; by Dr. Ami Boué, For. Mem. G.S. &c.

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On the Astronomical Causes which may influence Geological Phenomena ; by John Frederick William Herschel, Esq. F.G.S. F.R.S. &c.

January 5, 1831.—On the general structure of the Lake Mountains of the North of England, and on the great dislocations by which they have been separated from the neighbouring Chains ; by the Rev. Adam Sedgwick, Pres. G.S. F.R.S., Woodwardian Professor in the University of Cambridge.

Jan. 19 and Feb 2.—Supplementary Observations on the Structure of the Austrian and Bavarian Alps ; by Roderick Impey Murchison, Esq. Sec. G.S. F.R.S.

Feb. 16.—On the Geology of the Island of Juan Fernandez in the Pacific ; by Alexander Caldcleugh, Esq. F.G.S.

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A Letter from Peter Cunningham, Esq., to John Barrow, Esq., F.R.S., on the Geology of Hunter's River, New South Wales ; and communicated by Mr. Barrow.

*Sums actually Received and Expended,*

## RECEIPTS.

Balances in hand Jan. 1, 1830 :	£.	s.	d.	£.	s.	d.
Banker .....	419	4	6			
Accountant .....	43	5	0			
	<hr/>			462	9	6

Arrears :	£.	s.	d.			
Admission Fees .....	92	8	0			
Annual Contributions.....	79	11	6			
Repairing Fund .....	12	2	0			
	<hr/>			184	1	6

Ordinary Income :	£.	s.	d.			
Annual Contributions .....	468	11	6			
Admission Fees :	£.	s.	d.			
Residents .....	119	14	0			
Non-Residents .....	252	0	0			
	<hr/>			371	14	0
	<hr/>			840	5	6

Compositions, three .....	94	10	0
Transactions .....	418	5	0
Proceedings .....	3	11	0

Wollaston Fund .....	32	10	4
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£2035 12 10

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during the year 1830.

# PAYMENTS.

Bills outstanding from last year :	£.	s.	d.	£.	s.	d.
General Expenditure .....	23	4	0			
Salaries and Wages .....	79	4	6			
Stationery and Miscellaneous Printing .....	30	18	6			
Tea and Waiters .....	5	4	6			
Taxes, Parochial .....	14	10	0			
—, King's.....	42	16	5			
Repairs of House.....	15	19	1			
Publications, Transactions .....	519	8	8			
—, Proceedings.....	37	0	6			
Scientific Expenditure .....	67	8	2			
					835	14 4

General Expenditure :	£.	s.	d.	£.	s.	d.
Repairs of House.....	13	2	9			
Taxes, Parochial .....	29	10	6			
—, King's.....	53	1	4			
Insurance .....	6	0	0			
House Expenses .....	179	8	2			
				281	2	9

Salaries and Wages :	£.	s.	d.	£.	s.	d.
Curator .....	200	0	0			
Porter and Servant .....	90	0	0			
Collector's Poundage .....	14	6	0			
				304	6	0

Scientific Expenditure :	£.	s.	d.	£.	s.	d.
Books, Glass Cases, &c. ....	55	11	0			
Stationery and Miscellaneous Printing .....	43	3	2			
				98	14	2

Tea for Meetings .....	39	0	11			
				723	3	10

Cost of Publications:	£.	s.	d.	£.	s.	d.
Transactions .....	64	4	1			
Proceedings .....	35	3	4			
				99	7	5

Balances in hand Jan. 1, 1831 :	£.	s.	d.	£.	s.	d.
Banker .....	336	13	3			
Accountant .....	40	14	0			
				377	7	3

£2035 12 10

## VALUATION of the Society's Property; 31st December 1830.

PROPERTY.			DEBTS.		
	£.	s. d.		£.	s. d.
Balances in hand (see last sheet) .....	377	7 3	Taxes.....	15	0 0
Arrears due to the Society:			Sundries .....	29	4 4
Admission Fees .....	88	4 0	Collector's Poundage .....	9	10 6
Annual Contributions.....	142	6 6	Scientific Expenditure .....	4	2 0
	230	10 6			
Estimated value of unsold Transactions.....	788	12 6	Cash belonging to "Wollaston Fund" .....	57	16 10
			Arrears not likely to be received .....	60	7 4
			Balance in favour of the Society.....	70	0 0
				1208	6 1

[N.B. The value of the Collections, Library, and Furniture is not here included: nor is the "Donation Fund" instituted by the late Dr. Wollaston, amounting at present to 1084*l.* 1*s.* 1*d.* in the Reduced 3 per cent. Annuities; the dividends thereof being appropriated to the purposes suggested by the Founder.]

£1396 10 3	£1396 10 3
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We have compared the Books and Vouchers presented to us, with these Statements, and find them correct.

Feb. 10, 1831.

Signed, W. HENRY FITTON.  
J. H. RANDOLPH.

# ESTIMATES for the ensuing year: to 31st December 1831.

## INCOME EXPECTED.

Arrears due to the Society, Dec. 31st, 1830. (See last sheet . . . . .)	£	s.	d.
Ordinary Income for 1831 (estimated.)	230	10	6
Contributions of 155 Fellows . . . . .	£	s.	d.
Admission Fees:	465	0	0
Residents (20) . . . . .	126	0	0
Non-residents (25) . . . . .	262	10	0
Compositions, (three) . . . . .	853	10	0
	94	10	0

## EXPENSES ESTIMATED.

Debts outstanding 31st Dec. 1830:	£	s.	d.
Taxes . . . . .	15	0	0
Sundries . . . . .	29	4	4
Collector's Poundage . . . . .	9	10	6
Scientific Expenditure . . . . .	4	2	0
	57	16	10
General Expenditure:			
Repairs of House . . . . .	40	0	0
Taxes and Insurance . . . . .	109	0	0
House Expenses . . . . .	180	0	0
	320	0	0
Salaries and Wages:			
Curator . . . . .	200	0	0
Porter and Servant . . . . .	90	0	0
Collector's Poundage . . . . .	20	0	0
Scientific Expenditure and Stationery . . . . .	310	0	0
Miscellaneous Expenditure . . . . .	100	0	0
Publications:			
Proceedings . . . . .	40	0	0
Transactions . . . . .	500	0	0
	540	0	0
Arrears not likely to be received . . . . .	70	0	0
Employment of the "Wollaston Donation Fund" . . . . .	32	10	4
Balance in favour of the Society . . . . .	80	13	8
	£15	0	10

Sale of Transactions . . . . .	350	0	0
Dividends on "Wollaston Donation Fund" . . . . .	32	10	4
	£1561	0	10

The Report having been read, it was Resolved:—

1. That this Report be received.
2. That the thanks of the Society be given to the Rev. Professor Sedgwick, retiring from the office of President.
3. That the thanks of the Society be given to Leonard Horner, Esq., and Henry Warburton, Esq., retiring from the office of Vice Presidents.
4. That the thanks of the Society be given to Roderick Impey Murchison, Esq., retiring from the office of Secretary.
5. That the thanks of the Society be given to Arthur Aikin, Esq., Francis Chantrey, Esq., Sir Alexander Crichton, K.S.W. M.D., Captain Sir John Franklin, R.N., John Lindley, Esq., Dr. Roget, and Charles Stokes, Esq., retiring from the Council.

*The President, the Rev. Professor SEDGWICK, then proceeded to deliver the following Address, on announcing the first award of the Wollaston Prize:—*

BEFORE you proceed to elect the Officers and Council for the coming year, it remains for me to announce from the Chair the adjudication of the Wollaston Prize. The affecting circumstances under which it was founded, so short a time before the death of one of the most illustrious men who have adorned our lists, the earnest wishes he expressed, almost with his dying breath, for the honour and well-being of this Society, and the peculiar public interest attached to a first award, have thrown a more than usual responsibility upon the Council. We were deeply conscious of this responsibility; we have not come to our decision lightly; and in what we have done we look for your entire approbation.

I am anxious, in the first place, to recall to your recollection the powers committed to the Council, and the spirit of the instructions by which they were directed in their award; and I have no means of doing this so effectually as by quoting a portion of the communication, in which Dr. Wollaston first informed us of his intention of establishing the "Donation Fund." After stating that he had invested one thousand pounds in the three per cent. reduced bank annuities, in the joint names of himself and the Geological Society, he directed that after his decease "the Society should apply the dividends in promoting researches concerning the mineral structure of the earth, or in rewarding those by whom such researches might hereafter be made; or in such manner as should appear to the Council of the said Society for the time being, conducive to the interests of the Society in particular, or the science of geology in general," &c. And he afterwards enjoined the Society "not to hoard the dividends parsimoniously, but to expend them liberally, and, as far as might be, annually, in furthering the objects of the trust."

Such, Gentlemen, was the letter of our instructions: and as we were enjoined to expend the proceeds of the Donation Fund, as far as might be, annually, I will read an extract from the Report of the



Council at the preceding Anniversary, in explanation of our motives for withholding, on that occasion, the distribution of the dividends.

"The Council have not thought it expedient to make as yet any distribution of the dividends arising from this fund, but have appropriated the first year's income to the acquisition of a die for a medal which is to bear the head of Dr. Wollaston: and they hope that the Society will approve of this endeavour to perpetuate in the minds of geologists the memory of their illustrious benefactor. The first annual distribution, therefore, of the Wollaston Medal, as well as a certain sum of money, will be awarded at the next anniversary according to the provision of the bequest."—(Feb. 19th, 1830.)

Mr. Chantrey kindly undertook to carry the resolution of the Council into effect; and under his directions Mr. Wyon of the Royal Mint was employed to execute a die, which we hope before long to see finished. We met, therefore, in the early part of this year to act upon the letter of our instructions, and we recorded our award in the following Resolutions.

*Extract from the Minute-book of the Council, Jan. 11, 1831.*

*Resolved unanimously*—1. "That a Medal of fine gold, bearing the impress of the Head of Dr. Wollaston, and not exceeding the value of ten guineas, be procured with the least possible delay."

2. "That the first Wollaston Medal be given to Mr. William Smith, in consideration of his being a great original discoverer in English Geology; and especially for his having been the first, in this country, to discover and to teach the identification of strata, and to determine their succession by means of their imbedded fossils."

The first gold medal struck from the die now in progress will therefore be sent to Mr. Smith; and we have added to it a purse of twenty guineas, from the dividends of the "Donation Fund," which it is now my duty publicly to present to him in the name of the Geological Society. His great and original works are known to you all; and I might well refer to them for our justification, and without any further preface place the prize in his hand, offering him my hearty congratulations. But since his arrival in London, within the last few hours, he has given me a short account of his early discoveries, and has shown me a series of documents of no ordinary interest to this Society, and important to the correct history of European geology. I should ill perform my present task were I to withhold this information from you; I proceed therefore to communicate it with what brevity and simplicity I can.

Mr. William Smith was born at Churchill in Oxfordshire—a place abounding in fossils, the playthings of his childhood, and the objects of collection in his early youth. This is one of many instances where things, in themselves inconsiderable, act powerfully on peculiar minds, so as to influence the whole tenour of after-life. During his boyhood his habits of observation became confirmed by lessons in practical surveying: he remarked the alternations of argillaceous and stony strata, and thence became acquainted with the origin of springs and the

true principles of draining; and fortunately many practical works of this kind were carried on under his immediate inspection.

In 1787 (when eighteen years of age) he was employed in surveying and inclosing extensive tracts of common-land: this gave him a further insight into the minutest modifications of structure in his native country; and within the two next years his surveys extended beyond the oolite hills into the plain of the new red sandstone. The regular stratification of the lias and the peculiarities of the red ground, at that time new to him, made a lasting impression on his mind. Carrying with him his acquired habits of accurate observation, he continued his surveys (during 1790) to the coast of Hampshire, and to the country round Salisbury and Bath; and he became gradually familiar with the outline of the chalk downs, and the external characters of large agricultural districts. In 1791, while employed in making extensive surveys in a part of Somersetshire, he remarked the identity of the red marl and lias of that county with the corresponding formations of Gloucestershire, and recognized their discordant position on the coal measures. During the same year he made several detailed sections of the coal strata; collected fossil plants which he found characteristic of particular beds in his sections; and remarked that none of the many fossils of the lias were found either in the coal strata or the red marl: and at this time he also began to make practical observations and inquiries with a view of ascertaining the range and extent of the successive deposits, and the reality of a general line of dip towards the east, of which he had already seen so many local instances.

I think these facts of great importance, as they contain the germ of all Mr. Smith's future discoveries. And we must bear in mind—that his attention was distracted by the duties of a laborious profession—that he had barely reached the age of manhood—and that he had not received a glimmering of direction in his general speculations.

In the course of the two following years, while continuing the duties of a surveyor and civil engineer, he became gradually acquainted with all the minute facts of stratification in the country round Bath: and for the purpose of bringing to the test the inquiries suggested by his surveys in 1791, he made two transverse sections along the lines of two parallel valleys intersecting the oolitic groups (determining the actual elevation of these lines by means of levels carried from the Somerset Coal Canal); and ascertained that the several beds, found in the high escarpments around Bath, were brought down by an eastern dip, in regular succession, to the level of his lines of section. During these two years Mr. Smith was in the constant habit of making collections of fossils, with strict indications of their localities; and in completing the details of his transverse sections, he found, where the beds themselves were obscure, that he could by organic remains alone determine the true order of succession. During this period he also extended his surveys through the Cotteswold Hills, and became acquainted with the general facts of the range of the oolitic escarpment towards the North of England.

In the year 1794 he crossed the whole series of formations, and marked their escarpments between Bath and London; and afterwards

extended his surveys to the Durham and Northumberland coal-field: while on his way, partly by actual sections and partly by the help of external contours, with which his eye was now familiar, he ascertained the range of the chalk to Flamborough Head, and of the oolitic series, through a regular succession of escarpments, to the Hambleton Hills and the cliffs of Yorkshire. Combining the facts discovered in this excursion with the distribution of the formations in the south-western parts of England, he began to record his observations by colouring geological maps. Several documents of this kind are now unfortunately lost: but I have been informed by Mr. Phillips (Curator of the museum of the Yorkshire Philosophical Society), that he possesses a valuable geological map, coloured by Mr. Smith in the year 1800, connecting the structure of the North of England, which at that time he had not again visited, with the structure of the South-western districts; and delineating the whole oolitic series through England, in some places very correctly, and in all with a general approach to accuracy.

Mr. Smith in 1795 became for the first time a housekeeper; and no sooner had he apartments of his own, than he turned them to account by arranging his large collection of organic fossils (the accumulation of several years) stratigraphically. I am certain, Gentlemen, that this stratigraphical collection, preceded by many years any other similar collection formed in this country: and without pretending to any exact knowledge of the history of Continental geology, I greatly doubt whether a stratigraphical collection of organic fossils, derived from a long series of formations, and specially intended to assist in identifying their subordinate strata and determining their relations, was ever made before the year 1795 in any part of Europe.

Local collections of organic remains were undoubtedly made in this country long before the time of Mr. Smith, and in the works of our older writers we may sometimes find the glimmerings of his discoveries.—Woodward formed a magnificent collection of organic remains; and he separated from the rest a series of fossils of the Hampshire coast, and was aware that many of the species were the same as those of the London clay: but this fact, and many others of like kind, were with him but sterile truths; and being led astray by his theory, he knew nothing either of the real structure of the earth, or of any law regulating the distribution of organic forms.—Michell was a man of great talents, and undoubtedly made out the true relations of the secondary deposits in one portion of this island: but he was, I believe, ignorant of the importance of organic remains, and did not use them as a means of identifying strata.—Lister is distinguished among the writers of the seventeenth century as the first to propose the construction of mineralogical maps, and he had some limited notions of the distribution of organic fossils, though he misunderstood both their nature and importance.

The works of these authors were, however, entirely unknown to Mr. Smith during his early life, and every step of his progress was made

without any assistance from them\*. But I will go further, and affirm, that had they all been known to him, they would take nothing from the substantial merit of his discoveries. Fortunately placed in a country where all our great secondary groups are brought near together, he became acquainted in early life with many of their complex relations. He saw particular species of fossils in particular groups of strata, and in no others; and giving generalization to phenomena, which men of less original minds would have regarded as merely local, he proved (so early as 1791) the continuity of certain groups of strata, by their organic remains alone, where the mineral type was wanting. He made large collections of fossils; and the moment an opportunity presented itself he arranged them all stratigraphically. Having once succeeded in identifying groups of strata by means of their fossils, he saw the whole importance of the inference—gave it its utmost extension—seized upon it as the master principle of our science—by help of it disentangled the structure of a considerable part of England—and never rested from his labours till the public was fairly in possession of his principles. If these be not the advances of an original mind, I do not know where we are to find them; and I affirm with confidence, after the facts already stated, that the Council were justified in the terms of their award, and that Mr. William Smith *was* “the first, in this country, to discover and to teach the identification of strata, and to determine their succession by means of their imbedded fossils.”

\* I am anxious to do no injustice to those who preceded Mr. Smith. No part of Woodward's collection was arranged stratigraphically—Michell, who occupied the Woodwardian Chair several years, was of course intimately acquainted with every part of this collection: but I do not think he made any use of it as a means of determining the order of superposition. There is, however, one passage in his celebrated paper “On the Cause and Phenomena of Earthquakes” (Phil. Trans. vol. li. p. 587), which I am bound to notice. It is as follows: “These inequalities are sometimes so great, that the strata are bent for some small distance, even the contrary way from the general inclination of them. This often makes it difficult to trace the appearances I have been relating; which, without a general knowledge of the fossil bodies of a large tract of country, it is hardly possible to do.” I am almost certain, that by the term fossil, he did not intend organic remains. In the works and catalogues of Dr. Woodward (with which of course Michell was most familiar), and in the language of naturalists of the last century, every mineral substance was designated under the general term *fossil*; and organic remains were almost always distinguished by the name of extraneous fossils, organic fossils, &c. &c. The memorandum, by which it is proved that Michell had a knowledge of the true relations of several of our secondary groups, was found by accident among the papers of Sir Joseph Banks, and published in 1810. It could not, therefore, have possibly been known to Mr. Smith during the progress of his discoveries. (See Tilloch's Philosophical Magazine, vol. xxxvi. p. 102.)

Since the Anniversary, I have looked over the paper in which Lister recommends the construction of mineral maps (Phil. Trans. vol. xiv. p. 730: 1684). It is clear that he had no correct notions on the nature of stratification; and his opinions on organic remains were, as is well known, most erroneous and unphilosophical. All these questions are discussed at considerable length, and with great ability and candour, in an article of the Edinburgh Review (vol. xxix. p. 311, &c.), now known to be from the pen of Dr. Fitton. To this article I particularly wish to refer the reader.

After the year 1795, he turned his knowledge to effect in his various employments as civil engineer. Works of drainage were carried on by him on the principles of stratification—his stratigraphical collections were continually increased—he sketched geological sections on the lines of local surveys (many of which have been since published)—and traced geological lines of demarcation upon various county maps. Of these I may mention an excellent map of Somersetshire, coloured on the scale of an inch to a mile, and publicly exhibited and explained at an annual agricultural meeting at Bath, in the year 1799; and another map (publicly exhibited at the same time, and now, I rejoice to tell you, on the table of this Society) of the country six miles round Bath; representing all the different formations, and the minute subdivisions of the oolites, distinguished as they remain in our geological maps to this day. For eight or nine years he had been steadily and resolutely advancing, but without aid, and almost without sympathy; for he was so far before the rest of our geologists, if indeed they deserved the name, that they could not even comprehend the importance of what he had done. The public exhibitions I have alluded to, and the obvious practical interest of the subject, seem, however, at length, to have roused the attention of the scientific gentlemen near Bath: and it appears to have been during the meeting of the Agricultural Society, in 1799, that he first became acquainted with the Rev. B. Richardson of Farley, an excellent naturalist and a very extensive collector of fossils; and with the Rev. J. Townsend of Pewsey, whose literary and philosophic works are well known to you all. I will not do injury to this part of my narrative, by offering any comments upon these facts, but I will read you a letter I have just received from Mr. Richardson himself.

*Copy of Mr. Richardson's Letter.*

*Farley Rectory, near Bath,  
10th Feb. 1831.*

SIR,

I am requested to present you the particulars of my acquaintance with Mr. William Smith, well known by the appropriate appellation of Strata Smith.

At the Annual Meeting of the Bath Agricultural Society in 1799, Mr. Smith was introduced to my residence in Bath, when, on viewing my collection of fossils, he told me the beds to which they exclusively belonged, and pointed out some peculiar to each. This, by attending him in the fields, I soon found to be the fact, and also, that they had a general inclination to the south-east, following each other in regular succession.

With the open liberality peculiar to Mr. Smith, he wished me to communicate this to the Rev. J. Townsend of Pewsey (then in Bath); who was not less surprised at the discovery. But we were soon much more astonished by proofs of his own collecting, that whatever stratum was found in any part of England, the same remains would be found in it and no other. Mr. Townsend, who had pursued the subject 40 or 50 years, and had travelled over the greater part of civi-

lized Europe, declared it perfectly unknown to all his acquaintance, and he believed to all the rest of the world.

In consequence of Mr. Smith's desire to make so valuable a discovery universally known, I, without reserve, gave a card of the English strata to Baron Rosencrantz, Dr. Muller of Christiana, and many others, in the year 1801.

I am happy to hear that the Geological Society proposes to pay a deserved compliment to his merits, to which I most gratefully bear a willing testimony ; and am, Sir,

Most respectfully, Yours,

*The Reverend Professor Sedgwick,  
Trinity College, Cambridge\*.*

B. RICHARDSON.

Mr. Smith's views now expanded through the influence of sympathy and the hopes of patronage (too feebly answered in the event); and under the advice of the two gentlemen I have mentioned, he began to commit his thoughts to paper, and to designate the great subdivisions of our secondary series by names, many of which have been since almost universally current, and are adopted in our Society : and there now exists, in the hand-writing of Mr. Richardson, a geological table of our successive formations, dictated by Mr. Smith in 1799, for the express purpose of serving as the foundation of a memoir, to accompany an intended geological map of England. This very curious and important document is now placed before you ; and as it was the first tabular sketch of our formations, drawn up before he had, in conjunction with Mr. Richardson, finally decided upon the names by which they ought to be designated, you will remark, that the successive groups, from the coal measures to the chalk inclusive, are represented by a series of numbers, accompanied with explanatory notes, but without any proper names affixed to them.

At a great sacrifice, and great personal expense, Mr. Smith now began to extend his observations with a direct view to publication : and in 1801 he printed a very elaborate prospectus, of which I fortunately possess a copy (now on the table of the Society), containing proposals for publishing, by subscription, a work in 4to, entitled, "Accurate Delineations and Descriptions of the Natural Order of the various Strata that are found in different parts of England and Wales ; with Practical Observations thereon." The work was to have been accompanied by "a correct map of the strata, describing the general course and width of each stratum at the surface, and accompanied by a general section, showing their proportion, dip, and direction, and referring to the map by corresponding numbers and general explanations."

The concluding paragraph of the prospectus is so remarkable, that I will extract it entire :

"To attempt a complete history of all the minutiae of strata, would be an endless labour ; for a long life devoted to such a pursuit, must be inadequate to the purpose, considering the immense variety that is

\* The letter being addressed to me at Cambridge during my absence, was only received a day or two before the Anniversary.

to be found within this little island. But should the present Essay meet with that liberal patronage from the public which the author has reason to expect, it is his intention, in a future work, to give a particular description of the numerous animal remains and vegetable impressions found in each stratum; with an accurate detail of every characteristic mark that has led him to these discoveries."

Why his hopes of patronage were disappointed, and why his works were so long retarded, not by any want of zeal on his part, but by want of assistance from the public, it is not for me now to inquire.—The fact is not, however, difficult of explanation. At the time this prospectus made its first appearance, none of the magnificent discoveries of Cuvier and Brongniart were, I believe, published\*. The Geological Society of London had no existence—the branches of natural history connected with secondary geology were little cultivated, and indeed almost unknown in this country—and hence some persons perhaps doubted the reality of Mr. Smith's pretensions on a subject they had been taught to regard as empirical, and the public at large took little interest in what they did not comprehend. He suffered, therefore, as many men of genius have done before him, in his peace and in his fortune, from what in our estimation constitutes his chief honour—from outstripping the men of his own time in the progress of discovery.

The Geological Society was organized in the year 1807, and its Transactions are the true records of its labours and opinions. In the first volume of the first series, published in 1811, and composed of papers read during the four preceding years, there is one paper, and one only, containing any direct allusion to the great geological importance of organic remains. The allusion is conveyed in the following words—"To derive any information of consequence from fossil organized remains, on these subjects, it is necessary that their examination should be connected with that of the several strata in which they are found. Already have these examinations, thus carried on, taught us the following instructive facts:—that exactly similar fossils are found in distant parts of the same stratum, not only when it traverses this island, but when it appears again on the opposite coast: that in strata of considerable comparative depth fossils are found, which are not discovered in any of the superincumbent beds: that some fossils, which abound in the lower, are found in diminishing numbers through several of the superincumbent, and are entirely wanting in the uppermost strata †," &c. &c.

To this passage, the author appends a note, commencing as follows:—"This mode of conducting our inquiries was *long since recommended* by Mr. W. Smith, who first noticed that certain fossils are peculiar to, and are only found lodged in, particular strata; and who first ascertained the constancy in the order of superposition, and the continuity of the strata of this island," &c. &c.

\* The first memoir with which I am acquainted, explaining the views of these two illustrious authors respecting the phenomena of the Paris basin, was published in the year 1808, in the *Annales du Muséum*, tom. xi. p. 307.

† *Geol. Trans.* vol. i. 1st series, p. 325.

One quotation more, and I have done. The Reverend J. Townsend of Pewsey, in the first volume of a work published in 1813 (entitled "The Character of Moses established for Veracity as an Historian"), described at considerable length the secondary strata of England; and after referring nearly the whole of his information to Mr. Smith, adds the following words:—"The discoveries of this skilful engineer have been of vast importance to geology, and will be of infinite value to the nation. To a strong understanding, a retentive memory, indefatigable ardour, and a more than common sagacity, this extraordinary man unites a perfect contempt for money, when compared with science. Had he kept his discoveries to himself, he might have accumulated wealth; but with unparalleled disinterestedness of mind, he scorned concealment, and made known his discoveries to every one who wished for information. It is now eleven years since he conducted the Author in his examination of the strata which are laid bare in the immediate vicinity of Bath: and subsequent excursions in the stratified and calcareous portions of our island have confirmed the information thus obtained."

Knowledge thus orally communicated, gradually and insensibly became a part of the public stock; and beyond doubt "produced a very important, though unobserved effect upon the labours of all succeeding inquirers, who have been, perhaps unconsciously, but not less really, indebted to Mr. Smith for very essential assistance in their progress."—*Edinburgh Review*, vol. xxix. p. 313.

On what Mr. Smith has done since 1813, it is needless for me to dwell, as it is now a matter of public notoriety. But I may be pardoned for reminding you of his great geological map of England, published in 1815, which forms one of the decorations of this room—of a work accompanied by plates (published by Mr. Sowerby, in numbers, commencing, I believe, in 1816), entitled "Strata identified by their Fossils"—of a stratigraphical system, published in 1817, specially designed as an accompaniment to his collection of fossils purchased by the Treasury, and deposited in the British Museum—of his instructive series of sections, published at various times, and intended to illustrate his other works—lastly, of his twenty county maps, the result of incredible labour, and admirable for many of their details; and of a value known to every English geologist who has laboured in the field.

I for one can speak with gratitude of the practical lessons I have received from Mr. Smith: it was by tracking his footsteps, with his maps in my hand, through Wiltshire and the neighbouring counties, where he had trodden nearly thirty years before, that I first learnt the subdivisions of our oolitic series, and apprehended the meaning of those arbitrary and somewhat uncouth terms, which we derive from him as our master, which have long become engrafted into the conventional language of English geologists, and, through their influence, have been, in part, also adopted by the naturalists of the Continent.

After such a statement, Gentlemen, I have a right to speak boldly, and to demand your approbation of the Council's award—I could almost dare to wish, that stern lover of truth, to whose



bounty we owe the "Donation Fund"—that dark eye, before the glance of which all false pretensions withered, were once more amongst us. And if it be denied us to hope, that a spirit like that of Wollaston should often be embodied on the earth, I would appeal to those intelligent men who form the strength and ornament of this Society, whether there was any place for doubt or hesitation? whether we were not compelled, by every motive which the judgment can approve, and the heart can sanction, to perform this act of filial duty, before we thought of the claims of any other man, and to place our first honour on the brow of the Father of English Geology.

If, in the pride of our present strength, we were disposed to forget our origin, our very speech would bewray us; for we use the language which he taught us in the infancy of our science. If we, by our united efforts, are chiseling the ornaments, and slowly raising up the pinnacles of one of the temples of Nature, it was he that gave the plan, and laid the foundations, and erected a portion of the solid walls, by the unassisted labour of his hands.

The men who have led the way in useful discoveries, have ever held the first place of honour in the estimation of all who, in aftertimes, have understood their works, or trodden in their steps. It is upon this abiding principle that we have acted; and in awarding our first prize to Mr. Smith, we believe that we have done honour to our own body, and are sanctioned by the highest feelings which bind societies together.

I think it a high privilege to fill this Chair, on an occasion when we are met, not coldly to deliberate on the balance of conflicting claims; in which, after all, we might go wrong, and give the prize to one man by injustice to another; but to perform a sacred duty where there is no room for doubt or error, and to record an act of public gratitude, in which the judgment and the feelings are united.

Gentlemen, I will detain you no longer: Mr. Smith is now present, and though become grey in the service of science, you will rejoice to see that he still has the lineaments of vigorous health; and I cannot refrain, before I sit down, from expressing a fervent hope (in which you all will join me), that God may long preserve that life he has employed so much to his own honour, and the advantage of his country.

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The President then presented, in the name of the Society, a purse of twenty guineas to Mr. Smith, being a portion of the proceeds of the Wollaston Fund; and promised to forward to him the first gold medal struck from the die above mentioned. Mr. Smith, in a short and manly speech, returned thanks for the honour conferred upon him; expressed his anxiety to be still a useful servant of the public as a practical geologist; and, finally, presented to the Society some documents referred to in the President's address\*.

It was then proposed by Dr. Fitton, and seconded by George

\* Various papers detailing the history of Mr. Smith's researches will be found in the former series of the Philosophical Magazine; in vol. xxxv. p. 113, vol. xlii. p. 249, vol. liii. p. 112; &c.

Bellas Greenough, Esq., That the foregoing Address of the Rev. Professor Sedgwick be printed with the Annual Report.

The meeting next proceeded to ballot for the Officers and Council for the ensuing year; and on the glasses being closed, the scrutineers announced that the following gentlemen had been duly elected :—

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Rev. William Conybeare, M.A. F.R.S. Instit. Reg. Soc. Paris. Correspond.

Davies Gilbert, Esq. M.P. M.A. V.P.R.S. Hon. M.R.S. Ed. F.S.A. L.S. & H.S. M.R.I.A.

### *SECRETARIES.*

Edward Turner, M.D. F.R.S. L. & E. Professor of Chemistry in the University of London.

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Rev. W. Whewell, M.A. F.R.S. Professor of Mineralogy in the University of Cambridge.

*Address to the Geological Society, delivered on the Evening of the 18th of February 1831, by the Rev. Professor SEDGWICK, M.A. F.R.S. &c. on retiring from the President's Chair.*

I CONGRATULATE you, Gentlemen, on the general Report of the Council laid before the Society this morning. The number of names on our lists has increased by 45 since our last anniversary; and after discharging all the expenses of the past year, besides paying off 835*l.* of arrears, there remains a balance of more than 450*l.* to meet the ordinary expenses of the current year. We have now a clear property amounting in value to 1200*l.*, without including in this estimate our books, cabinets, and collections. Our Library has been enriched with many valuable works, and our Museum with large suites both of English and Foreign specimens. But it is not so much to the increase of our various collections as to the great progress made in arranging them, that I rejoice to call your attention. They have received an immense accession of value from the labour bestowed on them by Mr. Lonsdale, whose zeal, self-devotion, and great talents are now well known to you all. I heartily concur in the sentiments recorded by the Committee, and am convinced that no small part of our present prosperity is derived from our official connexion with that gentleman.

As a duty imposed on me by the office I have had the honour to fill, I now proceed to throw a retrospective glance over the memoirs which have come before us during the past year. To introduce them in chronological order would be attended by no advantage, and would deprive me of the power of showing their relations to each other, and of making such general comments as are compatible with the limits of this address. I shall commence, therefore, with the memoirs relating to the older formations, and pass on to those connected with the great secondary and tertiary groups; and in this way, without mingling matters of fact and speculation, I hope to lead you to the consideration of one or two great questions which have lately been pressed upon our attention.

A paper by Mr. Weaver on the physical structure of the South of Ireland demands our first notice. It is accompanied with a geological map, extending to the limits of a similar map of the East of Ireland, published by him in a former volume of our Transactions; and we have thus obtained from his unassisted labours an accurate geographical distribution of the formations spread over more than half that island. But great as they are, these are not the only obligations we owe to that excellent observer. He has described with the clearest details the various formations of the South of Ireland, commencing with the contorted and highly inclined groups of the older transition rocks, and ending with the unconformable deposits of old red sandstone and carboniferous limestone.

The order of succession, as far as it goes, is in exact accordance with that of our island, and the beds of transition limestone subordinate to the greywacké contain nearly the same series of organic remains as the corresponding beds of Gloucestershire, Cumberland, and South Wales. Amidst the uncertainty of some of our conclu-

sions derived from the organic types of deposits remote from each other, we seem in these transition fossils to have a secure starting point; and whether derived from the flanks of the Austrian Alps, the eastern plains of Galicia, the central regions of Russia, or the greywacké chains of northern Germany or North America, they have at least a family resemblance not easily mistaken.

In the limestone of Cork Mr. Weaver observed impressions of the vertebræ of fishes associated with the fossils abounding in the greywacké slate of the neighbouring country. The fact is in perfect accord with our present knowledge. Impressions of fish have long been known of in some varieties of transition slate; certain families of crustacea are eminently characteristic of formations of the same age; remains of fish are commonly found in the mountain limestone of Bristol; shark's teeth occur in the mountain limestone of Northumberland; and I need not perhaps remind you that impressions of fish (sometimes accompanied with crustacea) are found in incredible abundance among the bituminous schists associated with the old red conglomerates of Caithness. Yet such is the inveteracy of our prejudices in favour of the hypothesis which admits nothing but what we suppose the simplest forms of animal life into the older strata, that even now we receive the facts opposed to it with doubt and hesitation.

What above all distinguishes the greywacké series of the South of Ireland from the corresponding deposits in this country, is the occurrence of beds of pyritous shale abounding in impressions of Equiseta, Calamites, &c., and containing beds of coal (whence many thousand tons are annually extracted) interlaced with, and partaking of, all the flexures of the transition system\*. This fact, rendered doubly striking by the horizontal and discordant position of the true carboniferous limestone of the neighbouring districts, was an important addition to our information, and was heard with no small surprise by many members of this Society. It gives us, however, a new term of comparison with the phænomena of distant countries. The greywacké chain of Magdeburg contains innumerable impressions of true coal plants, and some of the carboniferous deposits on the confines of Westphalia partake (like the deposits in the South of Ireland) of all the contortions of the older transition series.

On the descriptions of the old red sandstone and the carboniferous limestone I shall make no comments; but I think it right to recall your attention to some valuable details respecting the metalliferous deposits in the counties of Cork and Kerry. The copper ore of Ross Island, on the lake of Killarney, does not constitute either metalliferous beds or true veins, but is distributed in the form of branches or strings, contemporaneous, like those of calcareous spar, with the

\* Small quantities of anthracite have been found here and there among the old slate rocks of Cornwall; and some portions of the oldest division of the slate series of Cumberland are so carbonaceous as to have given rise to borings and other works in search of coal. I have been informed that similar unsuccessful attempts were formerly made in North Devon. But in none of these instances, I believe, were true coal beds and plants, like those described by Mr. Weaver, ever discovered.

limestone rocks they traverse. At Mucruss mine, in the same neighbourhood, copper ore was obtained from a true metalliferous bed. In Kenmare the deposits of lead ore are shown to be discontinuous masses, nearly parallel in range and dip to the regular strata.

In the county of Cork the most valuable mine of copper is opened in a true vein: but the author remarks that in some parts of this county there is a very general diffusion of cupreous matter, sometimes appearing in separate particles, and sometimes in strings veins or filaments more or less connected with each other, but not continuous, and therefore contemporaneous with the rocks to which they are subordinate. Such repositories of metals might not inaptly be termed "*veins of segregation*," as they seem to have been formed by a separation of parts during the gradual passage of the mineral masses into a solid state.

In England we have almost every variety of metalliferous deposits. Near Whitehaven in Cumberland great masses of reniform hematite alternate with red beds of mountain limestone. At Nosterfield, near Bedale, a true bed charged with sulphuret of lead alternates with the upper strata of magnesian limestone. The great *copper pipe veins* of Ecton must have been contemporaneous with the shale limestone to which they are subordinate. The great lead veins of our northern counties originated, if I mistake not, in cracks formed during the elevation of the carboniferous chain, before the period of the new red sandstone.

In Cornwall we have, as is well known, both on the great scale and the small, every modification of veined structure. Tin is distributed through some of the granitoid rocks where no vein is visible. The slate rocks, near their junction with the granite, are traversed by veins of injection, and some of these are metalliferous, (for example, an elvan or porphyry dyke near St. Austell). The regular metalliferous *lodes* were probably once but cracks and fissures produced during some periods of elevation; and how they have been filled up is perhaps a question beyond our scrutiny. But after the important experiments of Mr. Fox, there can, I think, be no doubt that the great vertical dykes of metallic ore, which rake through so many portions of the county, owe their existence, at least in part, to some grand development of electro-chemical power.

In all the crystalline granitoid rocks of Cornwall there are also many masses and "*veins of segregation*." Such are the great contemporaneous masses and veins of schorl rock; and some of these are metalliferous. The decomposing granite of St. Austell Moor is traversed, and sometimes entirely superseded, by innumerable veins of this description. Upon these lines of schorl rock there is often aggregated a certain quantity of oxide of tin, which sometimes diffuses itself laterally into the substance of the contiguous granite. After examining this district with Professor Whewell during the summer of 1828, we left it in the conviction that several of the neighbouring tin works were opened not upon true *lodes*, but upon "*veins of segregation*." I only throw out these remarks as hints for future inquiry; as the subjects introduced by the memoir of Mr. Weaver are of vast importance,

and have been unfortunately but seldom brought under the consideration of this Society.

A paper by Mr. Alfred Thomas gives us some new details connected with the structure of the northern parts of Pembrokeshire. His descriptions are illustrated by a geological map, and a section extending north and south from Cardigan to St. Gowan's Head. By help of this section we are conducted, in a descending order, from the higher part of the coal series with subordinate beds of anthracite, through the mountain limestone, the old red sandstone and conglomerates, and the transition limestone with Trilobites, down to greywacké and greywacké slate. All these formations are occasionally traversed by masses of trap producing contortions and changes of structure among the rocks with which they are in contact.

In a communication read very recently to the Society, I have endeavoured to explain the structure of the Lake Mountains and the period of their first elevation—the manner in which, during a subsequent period of elevation, they were separated from the great calcareous chain of the north—and the relations they still bear to it through the intervention of a carboniferous zone. In conformity with the system first published by Mr. Otley of Keswick, I have shown that the greater part of the central region of the Lake Mountains is occupied by three distinct groups of stratified rocks of a slaty texture : and I have further shown, that crystalline unstratified masses form the true mineralogical centres of these great groups—that by the protrusion of these masses the schistose formations have been elevated into the positions they now occupy—and that a true mineralogical axis may be traced through the oldest division of the slate rocks, on each side of which the several formations, as far as they are developed, are arranged symmetrically. I have traced in great detail the range of a band of transition limestone imbedded in the upper portion of these older formations : and from the phenomena described, certain facts (important in the physical history of the mountain groups) become securely established.

1. Great cracks were formed at a very ancient epoch, and probably during the first period of elevation, diverging from the central regions of the Lake Mountains ; and such enormous shifts took place in the position of the shattered strata, that in several instances the broken ends of the same bed are more than a mile apart, the distance being measured in a direction at right angles to the lines of bearing. In after periods many of the existing valleys were scooped out upon the lines of fracture.

2. The central schistose groups abut in succession against the carboniferous zone ; and from this fact alone (independently of many others bearing upon the same point), the two systems are proved to be unconformable.

3. The mean bearing of the great central groups, notwithstanding their enormous dislocations, is, with very slight deviations, north-east by east, and south-west by west. Now this is nearly the mean bearing of the slate rocks of Cornwall, of the principal greywacké chains of Wales and of the Isle of Man, and also of the entire greywacké

chain extending across the South of Scotland, from St. Abbs Head to the Mull of Galloway: and it is, I believe, generally allowed, that these several chains, producing so great an impress on the physical character of our island, are all nearly of one age, and were probably all elevated nearly at the same period, before the complete development of the old red sandstone. Such a parallelism cannot surely be regarded as accidental, and offers, if I mistake not, a beautiful confirmation of the great principle in the late Essay of M. Élie de Beaumont, that mountain chains elevated at the same period of time have a general parallelism in the bearing of their component strata. In admitting such a principle, we must not however shut our eyes to the exceptions. Mr. Weaver has shown, that the mean bearing of the greywacké strata in the South of Ireland is east and west; and from his descriptions they appear to have been elevated before the deposit of the old red sandstone. The transition rocks of Devonshire and of a small portion of South Wales are nearly in the same direction, and parallel to the principal axis of the great Welsh coal-field.

I will not detain you, Gentlemen, with my speculations on the original extent of our carboniferous formations—on the different periods of elevation of the coal-fields on the Bristol Channel and of the great carboniferous chain of the North of England—on the different effects produced by the two systems on the range of the newer secondary groups—or on the causes by which the conflicting phenomena have been brought about.—I may however be permitted to remind you of the prevailing north and south bearings of the great carboniferous chain, from the latitude of Derby to the border of Scotland—of the great faults by which its western limits are tracked through the Peak of Derbyshire—of its prolongation through an anticlinal line into the high western moors of Yorkshire—and of the enormous breaks accompanying its escarpment from the heart of Craven to the foot of Stainmoor. The range and effects of one part of the great Craven fault have been described, with excellent illustrative sections, by Mr. Phillips of York. Taking the subject up where he had left it, I have traced a connected system of breaks to the foot of Stainmoor, and shown that by a prolongation of the great Craven fault, producing an enormous downcast on its western side, the entire carboniferous zone of the Lake Mountains has been nearly cut off from the central chain with which it must undoubtedly have been once continuous.

Another enormous break, passing under the escarpment of the Cross Fell range, meets the prolonged line of the Craven fault near the foot of Stainmoor. The forces producing this double system of disruptions appear to have been contemporaneous, and by their joint action have thrown whole mountain masses of the carboniferous series headlong into the valley of the Eden.

We have direct proof that all the fractures above mentioned took place immediately before the formation of the conglomerates of the new red sandstone; and we have the strongest reasons for believing, that they were produced by an action both violent and of short dura-

tion : for we pass at once from the inclined and disrupted masses to the horizontal conglomerates now resting upon them ; and there is no trace of any effect that indicates a slow progress from one system of things to the other.

Lastly, we have the clearest evidence to show that these vast disruptions were produced during the elevation of the carboniferous chain ; and, if I am not mistaken, during the same period arose many minor cracks and fissures, forming the moulds into which were, in after times, cast some of the richest lead veins of our island.

It is well known that the rich carboniferous deposits of this country undergo a great change of structure in their range from the Bristol Channel to the valley of the Tweed ; and I hope I shall not be thought to wander too far from my object, if I attempt shortly to explain in what the changes consist, and what are their modifications.

All our coal formations are essentially composed of mountain limestone, sandstone, and shale : they differ only in the mode in which these constituents are aggregated—In the various coal-basins on the Bristol Channel, the limestone-beds are developed only in the lower, and the coal-bearing-beds in the upper part of the series ; and the two members are separated by nearly unproductive deposits of millstone-grit and shale.

Almost in the same words we may describe the carboniferous series of Derbyshire. There, however, the millstone-grit is more complex, and of very great thickness ; and subordinate to the great shale are, here and there, very thick masses of a peculiar, thin-bedded and somewhat argillaceous limestone.

On the re-appearance of the carboniferous limestone, at the base of the Yorkshire chain, we still find the same general analogies of structure : enormous masses of limestone form the lowest part, and the rich coal-fields the highest part of the whole series ; and, as in the former instances, we also find the millstone-grit occupying an intermediate position. The millstone-grit, however, becomes a very complex deposit, with several subordinate beds of coal ; and is separated from the great inferior calcareous group (known in the North of England by the name of *scar limestone*), not merely by the great shale and shale-limestone, as in Derbyshire, but by a still more complex deposit, in some places not less than 1000 feet thick ; in which five groups of limestone strata, extraordinary for their perfect continuity and unvarying thickness, alternate with great masses of sandstone and shale, containing innumerable impressions of coal plants, and three or four thin beds of good coal extensively worked for domestic use.

In the range of the carboniferous chain from Stainmoor, through the ridge of Cross Fell, to the confines of Northumberland, we have a repetition of the same general phenomena. On its eastern flanks, and superior to all its component groups, is the rich coal-field of Durham. Under the coal-field, we have, in regular descending order, the millstone-grit, the alternations of limestone and coal measures nearly identical with those of the Yorkshire chain, and at the base of all is the system of the great *scar limestone*. The *scar limestone*



begins, however, to be subdivided by thick masses of sandstone and carbonaceous shale, of which we had hardly a trace in Yorkshire; and gradually passes into a complex deposit, not distinguishable from the next superior division of the series. Along with this gradual change is a greater development of the inferior coal-beds alternating with the limestone; some of which, on the north-eastern skirts of Cumberland, are three or four feet in thickness, and are now worked for domestic use, with all the accompaniments of rail-roads and steam-engines.

The alternating beds of sandstone and shale expand more and more, as we advance towards the North, at the expense of all the calcareous groups, which gradually thin off, and cease to produce any impress on the features of the country. And thus it is, that the lowest portion of the whole carboniferous system, from Bewcastle Forest along the skirts of Cheviot Hills to the valley of the Tweed, has hardly a single feature in common with the inferior part of the Yorkshire chain; but, on the contrary, has all the most ordinary external characters of a coal formation. Corresponding to this change, is also a gradual thickening of carbonaceous matter in some of the lower groups. Many coal works have been opened upon this line; and near the right bank of the Tweed (almost on a parallel with the great *scar limestone*) is a coalfield, with five or six good seams, some of which are worked, not merely for the use of the neighbouring districts, but also for the supply of this capital.

The beds of sandstone, shale, and limestone, forming the base of the carboniferous system in the basin of the Tweed, are often deeply tinged with red oxide of iron, and have been sometimes compared with the new, and sometimes with the old red sandstone. To the new red sandstone they have unquestionably no relations; and I should rather compare them (especially as the old red sandstone of the North of England seldom exists but as a conglomerate, and is seen in that form on the flanks of the Cheviot Hills) with the red beds of mountain-limestone and sandstone, which, both in Cumberland and Lancashire, sometimes form the base of the whole carboniferous series.

Such are the remarkable changes of our carboniferous system in its range from the Bristol Channel to the Scotch border: and it reappears on the north-side of the great greywacké chain of that country with so many points of analogy, that we must, I think, regard the coal measures in the neighbourhood of Edinburgh as part of a very ancient deposit, nearly of the same age with that on the banks of the Tweed\*.

Thus it appears, from what has been stated above—that tree

\* The general relations of the various groups of the carboniferous system of Northumberland, are, on the whole, very faithfully represented in the geological map of that county, published some years since by Mr. Smith. A very detailed description of a portion of the carboniferous series of the Tweed was read during the past year, by Mr. Winch, before the Philosophical Society of Newcastle, and has been since published. [See *Phil. Mag. and Annals*, N. S. vol. ix. p. 11.] Another paper, on the same subject. (which I did not see till these sheets were passing through the press), has been recently published by Mr. Witham of Edinburgh.

ferns, gigantic equisetæ, and other plants belonging to the herbarium of the ancient coal-fields, grew on the land, and were sometimes swept down into the sea, before the elevation of the grey-wacké chains of one portion of the British Isles—that in after times, the same families of plants were swept down into the sea, in immense abundance, and spread out, here and there, in beds alternating with mud, sand, and banks of zoophytes and sea-shells, during the whole period of the deposit of mountain-limestone, from its beginning to its end—lastly, that these mechanical accumulations continued to go on in shallow seas and estuaries (and perhaps also in inland lakes), till the whole process of degradation was interrupted by the elevation of the carboniferous chain, producing the enormous breaks and dislocations above described, and succeeded by the conglomerates of the new red sandstone.

Before I leave this subject, I may notice a work, just published by Mr. Witham of Edinburgh, containing many beautiful illustrations of the internal structure of fossil plants derived from the old coal-fields of the Tweed, and from various parts of Scotland. By submitting extremely thin, polished slices of these fossils to microscopic observation, he has been enabled to detect the minutest traces of organic texture; and he has proved the existence of so large a number of phanerogamic plants, in the lowest part of the carboniferous series, as greatly to modify one of the positions laid down in the *Prodromus* of M. Adolphe Brongniart.

A paper, by Dr. Buckland and Mr. de la Beche, on the Geology of Weymouth and the adjacent parts of the coast of Dorsetshire, brought before us all the secondary deposits of this island, from the lower division of the oolites to the chalk. It is so rich in its details, and adorned with such admirable illustrations, that the structure of the whole region, though crowded with formations, dislocated, contorted, and traversed by enormous and complicated faults, will hereafter be comprehended at a single glance; and the country will be visited as classic ground, where the most perfect types of our newer secondary groups may be studied under every variety of position and combination. Without attempting to follow the authors in their description of twelve of these successive groups, I may be permitted to remind you of the extraordinary bed between the Purbeck and Portland formations (first noticed by Mr. Webster), containing silicified trunks of coniferous trees and stems of *Cycadeoideæ*. From this paper, we learn, that these trunks lie partly sunk in black earth, like fallen trees in a peat-bog, and partly imbedded in the incumbent limestone; and that many of the stumps remain erect, with their roots in the black soil, and their upper portions in the limestone: and from these facts the authors conclude—that the surface of the Portland rock was once dry land—and that on it grew a forest containing plants of a tropical form—that this forest was submerged under the waters of an estuary or a lake, but with a movement so gentle, that neither the plants nor the soil were swept away—that upon this ancient forest were accumulated the mixed formations of the Wealds, not much less than 1000 feet in thickness—

and lastly, that the whole region was again sunk under the waters of a deep ocean, in which were deposited the great formations of green-sand and chalk. Continuing in the same spirit of induction, we might add—that these marine deposits again became dry land, upon which lived great tribes of palæotherian animals, now become extinct—that during this period were formed the lacustrine rocks of Hampshire and of the Isle of Wight—that it was succeeded by a sudden and violent convulsion, heaving on their edges the great deposits of the Isles of Wight and Purbeck, and at the same time producing the anticlinal axis and great longitudinal fractures, so well described in this memoir.

There can be no doubt that the same cause which upset the Isle of Wight, also produced the great breaks and fissures of the Weymouth district; and that this upheaving force (for such we must consider it) came into action at a recent geological period, is proved by the verticality of the lower lacustrine beds at the east end of the Isle of Wight. Whether this period was contemporaneous with the last elevation of the Eastern Alps may well admit of doubt: to substantiate a fact like this, many links are yet wanting in the chain of evidence; and England has, if I mistake not, been acted upon by far too many local disturbing forces, to be ever brought rigidly within the systems of the great European chains considered in the researches of M. Élie de Beaumont.

The investigation of the faults and dislocations interrupting the continuity of our secondary deposits is becoming, daily, a subject of increasing importance; and we are now called upon, not to regard them as solitary phænomena, but to trace them through whole regions, and to examine their relations to each other. These great theoretical and practical questions throw no common difficulties in the way of a person who is beginning the study of Geology: and it is especially on this account, that I regard the “Sections and Views illustrative of Geological Phænomena,” recently published by Mr. de la Beche, as a compendium, excellently fitted to assist the progress of our science.

Before finally quitting the subject of British secondary formations, I must mention a communication by Mr. Sharpe, describing a specimen of an *Ichthyosaurus* found in the lias near Stratford-upon-Avon. From the proportions of the vertebræ, the size of the paddle, and the circular or oval form of its component bones, as well as from other anatomical peculiarities, the author concludes, that this animal belongs to a new species, for which he proposes the name of *Ichthyosaurus grandipes*.

Facts illustrating the structure of distant regions of the earth have their value greatly enhanced by the difficulty of obtaining them. Every gleaning of information on the physical history of Australia or the Isles of the Pacific, will be received in this Society with the deepest interest. I will not, however, detain you with any analysis of the paper by Mr. Cunningham on the Geology of Hunter's River in New South Wales, or of that by Mr. Caldeleugh on the

Physical Structure of the Island of Juan Fernandez, as the important parts of their contents must be still fresh in your recollection, and they offer no materials from which I can draw any general, theoretical conclusions.

Connected with the primary and secondary formations of Continental Europe, several communications have come before the Society. Of these I must first notice two short memoirs, accompanying geological maps of Moravia and Transylvania, by Doctor Boué; and a longer and more elaborate memoir, by the same author, explanatory of a geological map of Austria and Southern Bavaria. I need not inform the gentlemen whom I am addressing—that this indefatigable observer has spent many years of his life in disentangling the complex phenomena of the Alps—that he has extended his surveys through Moravia and the great Carpathian chain, to the province of Transylvania—that combining his own observations with those of De Lill, Beudant, and others, who had in part preceded him, he has been enabled to exhibit the geological relations of this vast region, and through the intervention of common deposits to bring it into accordance with the system of the Austrian Alps. It is obviously impossible for me to offer any analysis of such labours, of which the three maps presented to the Society are most honourable records.

It would be equally impossible to give, with any effect, an abstract of the several memoirs of Dr. Boué; for they bring before us so many facts, and in so condensed a form, that they seem to contain materials hereafter to be expanded into works far beyond the limits of any ordinary communication. On these subjects I must therefore be content to refer you to the printed analysis of his papers, and to his various essays, published during the past year, on the structure of the Alpine and Carpathian chains\*.

In elucidation of the geology of the Eastern Alps, a paper was also presented to the Society, during the past year, by Mr. Murchison and myself. Our object was, by help of a transverse section along the line where we crossed the Chain, to bring together such facts as were seen by ourselves, and appeared of any real importance: and, connecting them with other facts, partly derived from oral information, and partly from a number of scattered memoirs little known in this country, to give such an outline of the general structure of the whole chain, as should be intelligible to an English reader.

As our Memoir has been published, I should hardly have alluded to it, had not our views been partially misrepresented; and, what is of vastly more importance, had we not differed from Dr. Boué in the interpretation of some very singular, and we think not unimportant, phenomena.

During the past year, Mr. Murchison again visited the same region; and the results of his investigations have been laid before us in an elaborate paper, which I am now called upon to notice. In doing

\* See especially several elaborate articles on these subjects, published by Dr. Boué, during the past year, in the *Journal de Géologie*.

this I am compelled so far to retrace my own steps as to bring to your recollection the geological subdivisions of the Alpine chain adopted in our published Memoir. We stated that the Eastern Alps, considered in their greatest simplicity, might be described as a mountain chain with an axis of primary rocks, flanked and surmounted by two great secondary calcareous zones, which are in their turn surmounted by vast tertiary deposits, descending on one side into the plains of Italy, and on the other into the plains of the upper Danube; and that the same great physical region, when considered in more detail, might be separated into formations admitting of a general comparison with those of our own country in the following order, commencing with the lowest. 1. Primary rocks of the central axis. 2. Highly crystalline deposits graduating in the ascending order into rocks conforming to the ordinary transition type, and containing, though very rarely, transition fossils. 3. Red and variegated sandstone and gypseous marls, sometimes alternating with masses of magnesian limestone. 4. Older Alpine limestone—a formation of enormous thickness, supposed to represent a part of the oolitic series, and based upon fetid dark-coloured limestone and other strata which we endeavoured to identify with the lias. 5. Limestone and sandstone with great masses of saliferous marls rolled up and encased among the contorted strata. 6. Younger Alpine limestone, including all the secondary deposits of the Alps superior to the saliferous system, and containing two distinct groups; the first of which was supposed to represent the highest portion of our oolitic series, and the second (or Vienna sandstone) the whole system of the green-sand and chalk. 7. Tertiary deposits.

Between the two subordinate groups of No. 6. we were not able to draw any precise line of separation; and, to our surprise, we were still less able to define the limits of the secondary and tertiary series. For, sometimes resting unconformably among the serrated peaks of the higher mountains, and sometimes in a position intermediate between the outer zone of the chain and the tertiary plains descending towards the Danube, we found great complex deposits, apparently graduating at one extremity into the secondary, and at the other into the tertiary system, and abounding in fossils, which in a great majority of the species seemed to conform to the tertiary type. Upon this mixed evidence we concluded that these singular deposits formed a true connecting link between the secondary and tertiary systems of the region; and, though unknown in our own country and the North of France, were to be placed somewhere between the *calcaire grossier* and the chalk.

To the clearing up of this point (on which alone we had any essential disagreement with Dr. Boué), Mr. Murchison has devoted the most elaborate details of his recent Memoir. He first describes the extension of the primary axis into the Leitha-gebirge, which thus seems to form a connecting link between the Alpine and Hungarian chains, and notices some new and interesting localities of the magnesian limestone and red marl series. He then traces the reappearance of the gypseous and saliferous marls, apparently of the age of the new red sandstone, in some longitudinal valleys of the Salzburg Alps; and by means of detailed sections, fixes the great salt deposits

of Aussee and Halstadt between the older Alpine limestone based upon lias, and the newer limestone terminating in the Hippurite rock. He afterwards gives various sections of the Vienna sandstone group, and shows that it is the equivalent of the green-sand and chalk; and proves, by very elaborate details, chiefly derived from the banks of the Traun, that in the enormous development of the nummulite series one part graduates into the secondary, and another into the tertiary system of the Eastern Alps; thus confirming by new and uninterrupted sections the justness of our former classification.

Among the novel and important observations in this Memoir, the author describes a deposit, at Ortenburg in the valley of the Danube, composed of chalk with flints, supporting tertiary sands and clays, and resting horizontally upon the primary rocks of the Bohemian chain. Arguing from this fact he shows, (agreeably to the system of M. Élie de Beaumont,) that the elevation of the Alpine and Bohemian chains took place at two distinct periods.

In glancing over the various papers on the structure of the Eastern Alps, it was impossible for me entirely to separate the descriptions of the older and newer systems; but I now proceed to notice some communications almost exclusively devoted to the phænomena of tertiary deposits.

A paper was laid before the Society by Mr. Murchison and myself, during the past year, on the Tertiary Formations of Lower Styria. In an east and west section, from the Styrian Alps to the confines of Hungary, we describe a long succession of marine strata; commencing, as we have endeavoured to prove by the imbedded fossils, with rocks of the Palæotherian period, and ascending through the middle Sub-Apennine system to a large group of strata, apparently containing several species of recent shells, and of the same age with the higher deposits of the Vienna basin. Yet in this most recent group are masses of limestone exhibiting so fine an oolitic structure, that by hand specimens alone we should find it no easy task to separate them from the great oolite of Bath.

In another section from north to south, we have shown the association of the upper tertiary groups with the rugged volcanic rocks which start out from the eastern plains of Styria: and from all the complicated phænomena we conclude, that the volcanic forces were first called into action in this region during the most recent tertiary period, and were probably continued for a long succession of ages, during which the sea was spread over the lower portions of Styria and Hungary; and that no test can be established whereby we can fix the ages of the different igneous productions: inasmuch as the same groups of strata are in one place covered by basaltic lava, in another by trachyte, in a third by volcanic conglomerate, and in a fourth alternate with volcanic sand and breccia. Lastly, we have in the discontinuous masses of volcanic breccia, and in the rude and interrupted escarpments of trachytic and basaltic rocks, the clearest and most emphatic proofs of enormous degradation, within a period of time bounded by one of the newest regular formations of geology.

Before quitting this subject I may add, that Mr. Murchison has, in

his last Memoir, identified all the groups of the Vienna basin with those of our Styrian sections. The inferior blue marl (or *Tegel*) of that basin is supposed to be the equivalent of the London clay; the white coralline limestone of the Leitha-gebirge is placed on the same parallel with the limestone of Wildon; and the higher accumulations of sand and gravel are compared with the upper formations of Lower Styria, through which, as stated above, the basaltic and trachytic eruptions have made their way.

The papers of Colonel Silvertop, on two lacustrine deposits in the province of Granada, placed before us an interesting sketch of the structure of a region little known to the geologists of this country. After pointing out the primary formations of the Sierra Nevada, and the recent marine strata near the southern base of the chain, he describes the large freshwater basins of Baza and Alhama, occupying two deep depressions on its northern declivity. The strata of the former basin are subdivided into two great groups; the lower composed of marls with many fossils of the genus *Cypris*, and containing brine springs, gypsum, and sulphur; the upper composed of light-coloured indurated marl and limestone, charged with innumerable *Paludinae*. The basin of Alhama gives very nearly a repetition of the same phenomena: but among its indurated white marls is a larger number of organic remains, some of which very nearly resemble those of the freshwater limestone in the basins of Paris and the Isle of Wight.

It is not necessary for me to point out the importance of facts like these; and I am not called upon to follow the author through his details, as his communications are already published.

On the subject of tertiary deposits, I have finally to notice a communication by Mr. Pratt, who found, during last summer, in the lower freshwater marls of Binstead in the Isle of Wight, many comminuted or rolled fragments of the bones and teeth of several species of Mammalia, mingled with pulverized shells, and with the bones of two or three species of freshwater turtles, resembling those described by M. Cuvier from the Paris basin. Among the more perfect specimens of these fossils, the author found a tooth of the *Anoplotherium commune*, and the teeth of two species of *Palæotheria*; thus confirming a previous discovery made known by Mr. Allen, and perfecting the zoological analogy between the newer lacustrine formations of England and central France.

The bones of the Binstead marls do not however belong exclusively to the order of *Pachydermata*; for the author also found the jaws of a ruminating animal closely allied to the genus *Moschus*, but at the same time differing in some essential characters from every species hitherto described; and he gives us reason for sanguine hope, that large additions may be hereafter made to his very important list of new fossil quadrupeds. All the magnificent generalizations of Cuvier, as far as they are borne out by the zoological phenomena of the Paris basin, apply therefore literally to the more recent physical revolutions of our own country.

Among the papers published in the early volumes of our Trans-

actions, none excited a greater or more deserved interest than those of Mr. Webster. But first generalizations are almost always pushed too far. After being bewildered with the observation of unconnected facts, the first glimmering of general truth is so delightful, that it often leads us beyond the bounds of fair induction. We are then compelled to retrace our steps, and cast about for new phenomena; and it is only after a succession of trials and adjustments, that the facts we had at first partially misinterpreted are seen at their proper level, and with their true bearing upon each other. The broad conclusions of Mr. Webster, in his comparison of the basins of Paris and the Isle of Wight, are however too firmly established to be ever shaken; and it is only in his estimate of the subordinate groups that his early essays require either revision or correction: and surely it is no reproach to him that he did not foresee the subsequent discoveries of MM. Cuvier and Brongniart.

The *argile plastique* of Paris is now regarded as a mere local lacustrine deposit. The *plastic clay* of this country is, on the contrary, an arenaceous formation of enormous thickness, not merely coextensive with, but often stretching far beyond the limits of, our tertiary basins; and containing, here and there, subordinate argillaceous beds, and many marine shells of the same species with the characteristic fossils of the London clay.

The deposits of the Isle of Wight above the London clay are subdivided (in all our published works) into three principal groups,—the upper and the lower composed of calcareous lacustrine marls in different states of induration—the middle one of argillaceous marls supposed to be exclusively of marine origin. But it has been long known to many of the gentlemen I am now addressing, and to no one better than Mr. Webster—that in Headdon Hill (which gave the types of all his formations above the London clay), the middle argillaceous group contains innumerable freshwater shells, greatly predominating over the marine, and bands of lacustrine marl differing in no respect from that of the upper and lower groups—that in Norton Cliff (about two miles north of Headdon Hill), the three groups are mineralogically well developed without containing a single marine fossil—that at Hampstead Cliff, where the argillaceous marls have four or five times their average thickness, no undoubted marine shells appear on the true parallel of the *upper marine formation*\*—and that in many other parts of the Isle of Wight the three groups admit not either of mineralogical or zoological separation from each other; but are composed, from top to bottom, of an indefinite number of alternations of argillaceous and calcareous marls, passing at one extremity into soft unductuous clay, and at the other into freshwater limestone†.

\* In the highest part of the argillaceous marls of Hampstead Cliff (about two miles east of Yarmouth), there are, however, two species of *Corbula*; but they occur, if I mistake not, far above the parallel of the "*upper marine marls*" of Headdon Hill.

† Anomalies, similar to those pointed out above, are stated also to occur in portions of the Paris basin, and may perhaps hereafter be used as terms of comparison with the structure of the Isle of Wight.



Facts like these prove, if I mistake not, the impossibility of instituting any rigid comparison between all the successive groups in the basins of Paris and the Isle of Wight. But discrepancies in minute details militate in no respect against Mr. Webster's leading generalizations, which have received such a striking and unlooked-for illustration in the fossil mammalia of Binstead. If the hints now thrown out should induce him to lay before the public some part of his valuable observations on our different tertiary deposits, or to hasten the publication of his long-promised work on the Isle of Wight, my present purpose will be completely answered.

In these papers, a brief analysis of which I have now placed before you, we have some new and striking proofs of the great importance of organic remains in determining the comparative age of remote and discontinuous formations. And we have seen that in cases where we have few examples of specific agreement, we can, from the aspect of large groups of fossils and the general resemblance of their generic types, form at least a probable estimate of the age of the deposits to which they are subordinate. Inferences of this kind would be altogether worthless were they invalidated by the direct evidence of geological sections. But we deny that this is in any respect the case; and our conclusions are the more certain, because they are not only founded upon a wide induction of particulars, but are consistent among themselves.

There can be no doubt that in the ancient ocean, as well as in the present, the distribution of organized beings was affected by many causes—by the temperature and depth of the waters—by the nature of the soundings—by the action of tidal currents—and by other unappreciable disturbing forces. Even among the old secondary groups we can sometimes separate littoral formations from those of deep seas, not merely by their mineral structure, but also by their fossils: and in all geological periods of the history of the earth, formations on the shores and formations in deep seas must have gone on together.

Again, our great formations may be subdivided into many distinct mineralogical groups of strata; and the large suites of organic remains, characteristic of the formations as a whole, may also be subdivided into many groups, the species being defined by the mineral structure of the beds to which they are subordinate.

All this is in harmony with the distribution of the animal kingdom in the existing seas. Some animals may be found almost indifferently on a calcareous, a sandy, or a muddy bottom (for example, the floating cephalopods); and the remains of ancient animals of kindred organization occur indifferently in calcareous, siliceous, and argillaceous groups of strata. Some animals have lived and propagated under the waters of a muddy shore; the remains of these occur abundantly in our secondary beds of shale. To the very existence of some shells calcareous rocks are necessary; and on banks of mud or moveable sand, corals and attached zoophytes could find no proper resting place. Hence it is that many species of shells and zoophytes are chiefly characteristic of limestone strata; and if they exist at all

in other beds, have probably been drifted there by the action of marine currents.

It follows from these remarks, that any great change in the mineralogical character of a formation must also be accompanied with a corresponding change in the accompanying forms of organic structure once subservient to life. In this way we may explain the great difference between the organic remains of the lower oolitic series of western and central England, and of the contemporaneous coal formation on the Yorkshire coast. And in the same way we may also explain an opposite fact, observed more than once by Mr. Murchison and myself during our traverses through the Eastern Alps, that wherever a secondary deposit of that great chain approaches the mineral type with which we are familiar in this country, it also contains an imbedded group of organic remains very nearly resembling those we have been taught to regard as characteristic of the formation.

I believe that the subject to which I am now pointing is one of interest and importance; and I know no one who could do so much justice to it as Mr. Lonsdale, whose admirable knowledge of recent and fossil species, and of the minutest subdivisions of our secondary groups of strata, (strengthened and improved as it is by the performance of the great task he has undertaken so much to the advantage of this Society,) qualifies him to compose an essay which will throw the greatest light upon the physical causes affecting the distribution of organized beings during the long periods of geology.

In a paper by Mr. Yates, the last I have to notice in connection with our ordinary subjects of discussion, we have a minute detail both of the processes regulating the production of alluvial matter, and of the forms it assumes during its accumulation. He first considers the causes of disintegration, independent of the immediate action of running water; among which he principally enumerates earthquakes, landslips, the various effects of oxidation, and the expansive powers of frost. He then describes the distribution of the comminuted materials by running water, the manner in which they become piled into obtuse cones in passing from lateral to principal valleys, and the various causes modifying the erosive power of rivers. From these subjects he proceeds to the forms assumed by alluvial silt when carried down into standing water, the manner in which lakes become gradually filled up, and the inclination of the stratified masses resulting from the operation. Lastly, he describes the effects produced at the junction of two streams, the depositions on the intermediate stagnant points, and the forms of alluvial masses, whether in rivers or lakes, produced by this compound action; and, from the observation of these forms, he draws some practical conclusions respecting the probable accumulations at the bottom of the sea by the opposition or the union of currents, whether flowing at the same or at different levels.

Questions of this kind are of most obvious importance; but they admit of no illustration except by details ill fitted for the nature of this address. I may however, before I finally quit this subject, remind

you of two opposite facts recorded in papers very lately read in this Society, especially as they strengthen an opinion advanced at our last anniversary—that the river drainage of every physical region is a complex result, always modified by local conditions, and often depending upon the action of many successive causes. I have already shown that in a part of Cumberland and Westmorland the valleys are excavated upon the lines of ancient breaks or fissures. On the contrary, in the neighbouring carboniferous chain of Yorkshire, the faults and dislocations hardly ever range in the directions of the valleys, and do not seem to have produced any sensible effect upon the directions of the erosive currents.

Again, the valleys of the carboniferous chain are of great depth, and the strata on their opposite sides are generally horizontal and at the same level; yet within these valleys we have in every river and every tributary torrent, proofs, in my opinion the most unequivocal, that the channels where the waters now flow have only existed during a very recent period.

I mention these facts for the purpose of urging upon you the important truths, that geology has little to do with the combinations of simple elements, and that we are in most cases called upon sternly to reject such conclusions as are founded only upon particular phenomena.

Such, Gentlemen, are the subjects which have come before us during the past year. They are neither small in number nor unimportant in their objects; and whatever may be their other merits, they at least prove that our body has manifested the activity of healthy life. As we advance on our way, we gain strength at every step; but new and loftier subjects of contemplation are continually rising up before us; so that as yet we have no glimpse of the furthest boundary to our prospects and our labours. And in all this there is a perpetual motive for combination and energy and hope, and for the exercise of all those faculties which are called forth in the great journey of discovery.

We have indeed neither the time nor the power to slumber; and, in spite of ourselves, we cannot but partake of that forward movement by which all our neighbours are borne along. The continental press teems with admirable works on every department of natural history; and our subject has obtained, to say the least, its full share of consideration. Professor Hoffman's map, alluded to in my former address, will soon be illustrated by a work which promises fair to make the north of Germany once more the classic land of geology. The excellent *Memoirs of MM. de Beaumont and Dufrénoy* will soon be followed by the *Geological Map of France*,—a great national work, to appear, I hope, before the expiration of this year. I select these subjects, not merely on account of their general importance, but because they have an immediate relation to the structure of this country, and to the best labours of our own body.

The organization of the Geological Society of Paris belongs to the history of the preceding year: and when we consider the incompa-

rable collections of that capital, and the illustrious naturalists who are there assembled, we confidently look to this association for results which shall greatly affect the future history of our science. With ordinary fortune it can hardly fail to become a great central point of union, where geologists from all the nations of Europe may from time to time meet together with no rivalry but in the love of truth.

Our studies, Gentlemen, have no part in those bad passions by which mankind are held asunder; the boundaries of tribes and nations are blotted out from our maps; the latest revolutions we treat of are anterior to the records of our race, and compared with the least of the monuments which we decipher, all the works of man's hand vanish out of sight. If we have advanced with a vigorous step for the last fifteen years, it has been during the peace of the civilized world. The foundations on which we build are so widely parted, that we require nothing less than a free range through all the kingdoms of the earth; and if anything should occur to cloud our prospects or retard our progress, it must be accompanied by some moral plague which will desolate the face of Europe. Against the visitation of such a calamity, every man whom I now address will join with me in heartfelt aspirations.

Geology is a science of observation: and it is a humiliating fact, forced upon us at every step of our progress, that the material combinations we investigate and attempt to classify are too rude and ill defined to be regarded as the appreciable results of any simple law of nature. Some great and simple problems in physics have however so immediate a connexion with the structure of the earth, that we may almost claim their solutions for our own.

The form put on by a fluid body in rotation is an abstract question, which might or might not have any real application to the bodies of our solar system. But direct geodesic observations, as well as the relative position of land and water, prove that the stratified matter on the crust of the earth is deposited in near conformity to the surface of a true spheroid of rotation. Here then we have, in spite of one of the arbitrary dogmas of the Huttonian theory, an indication of a primeval fluidity before the commencement of any one phenomenon coming within the direct speculations of geology. And again, the direct phenomena of geology are in the strictest harmony with this conclusion. For, after passing through a few stages of stratified matter, formed by the degradation of matter in a prior state of solidity, we are conducted to other unstratified masses with that crystalline structure which implies an anterior fluidity—in some cases unequivocally, and in all cases probably, derived from the solvent power of heat.

But if the earth ever existed in any state approaching to igneous fusion, it must have undergone a great diminution of temperature before it was fitted for the habitation of any organized being. And here again geological facts are at least in a general accordance with the hypothesis; for the forms of the living beings entombed among the ancient strata, not only seem to indicate a

high temperature, but also a gradual refrigeration of the surface of the earth.

Here however we meet with an unexpected difficulty. If during any period the earth have undergone a sensible refrigeration, it must also have undergone a contraction of its dimensions; and also, as a necessary consequence of a well known mechanical law, an acceleration round its axis of rotation. But direct astronomical observations prove that there has been no sensible diurnal acceleration during the last 2000 years; and therefore, by inverting the steps of the reasoning, we prove—that during that long period there has been no sensible diminution in the mean temperature of the earth. This difficulty does not, however, entirely upset the previous hypothesis: it only proves that the earth had reached an equilibrium of mean temperature before the commencement of good astronomical observations.

But if, Gentlemen, our speculations are thus limited and guided by the observations of astronomy, we have in part paid back to that exalted science the obligations we owe to it. The great bodies of our system leave behind them no marks to track their progress through the heavens; and the vast secular periods we can calculate, reaching to ages long anterior to the records of our being, might be mere fictions of the mind which have never had any archetype in nature. But in the phenomena of geology we are carried back, almost at our first step, into times unlimited by any narrow measures of our own; and we exhibit and arrange the monuments of former revolutions requiring for their accomplishment perhaps all the secular periods of astronomy. Nor is this all. We show by help of records, not to be misinterpreted, that during this vast lapse of time, in the very contemplation of which our minds become bewildered, the law of gravitation underwent no change, and the powers of atomic combination were still performing their office.

If the phenomena of geology be coeval with long returning astronomical periods (and it is at least impossible to prove the contrary), a question may arise, whether some of the first difficulties we meet with (such as those connected with the transport of diluvial gravel, and the gradual diminution of temperature,) may not be attributed rather to effects of planetary perturbation than to any change in the internal condition of the earth. This question has been admirably discussed in a recent paper by Mr. Herschel.

Of all the secular inequalities produced by perturbation, those of the moon alone can produce any visible effects upon the tidal level. The lunar inequalities considered are of two kinds—change of mean distance, and change of eccentricity. Both are confined within narrow determined limits; and Mr. Herschel shows, by actual calculation, that they could not have produced any of the great movements contemplated in geology.

The planetary perturbations of the orbit of the earth are next considered, and the influences they may have produced on the diffusion of light and heat. The secular variation of obliquity is too small to have ever caused any sensible effect on our climates:

but he proves, by direct calculation, that the mean annual diffusion of solar light and heat varies inversely as the minor axis of the orbit; or, in other words, increases or diminishes with the increase or diminution of eccentricity. Now, as a matter of fact, the eccentricity of the earth's orbit has been for many ages slowly diminishing, and is now very small; but the limits of its secular variation have not yet been calculated. He assumes therefore, hypothetically, that the eccentricity of our orbit *may* once have been as great as that of some of the inferior and superior planets; and on that supposition he proves, that the slow diminution of eccentricity *may* have produced a gradual change of climate, of the very kind indicated by geological phænomena.

Several other great modifications in the diffusion of light and heat are involved in this hypothesis, one only of which I will mention, as it can be easily explained. It is well known that the place of the apogee and the equinoctial points are both in continual movement; and after the completion of a long cycle, these points will have travelled through the whole circumference of our orbit; whence it follows—that, during one part of the great astronomical cycle, our summers would coincide with the greatest, and during another with the least distance from the sun. And these conditions, in an orbit of considerable eccentricity, would produce, at one time a climate resembling perpetual spring; at another, the extreme vicissitudes of a burning summer and a rigorous winter.

Whether influences of this kind ever have caused any considerable changes in the climate of different portions of our globe, must, however, still remain in doubt, as the calculations are only founded on analogy. We rejoice, however, to associate our science with these lofty speculations, in which man seems to be no longer a worshiper at the portal of Nature's temple, but is allowed to pass within, and to be so far a partaker of her mysteries, as to see with his intellectual eye both the past and the future.

I believe that the law of gravitation, the laws of atomic affinity, and, in a word, all the primary modes of material action, are as immutable as the attributes of that Being from whose will they derive their only energy. But it is not merely through the simple and unchangeable modes of material action, or through the simple laws by which the parts of material things are bound together, that the works of nature are submitted to our senses. The things we see on the surface of the earth are in a continual state of movement and change, of destruction and renovation. They are not merely subject to those fundamental powers, commonly considered as the laws of nature; but the very powers themselves act under such endless modifications, sometimes combined together, and sometimes in conflict, that there follow from them results of indefinite complexity, the very simplest of which are removed far out of the reach of any rigid calculation.

As the primary laws of matter are immutable, every physical experiment tried under the same conditions must end in the same

results, whether they be chemical, or mechanical, or a compound of both. But let any new and unknown condition be introduced, and the results are not only changed, but are often the very contrary of what we should have at first anticipated. Let it again be considered within what narrow limits we have the power of modifying the conditions of any physical experiment, and how little we still know of those mysterious imponderable agents which co-exist perhaps, with gravitation, and unquestionably play their part in every change and every combination—and we must see the utter hopelessness of bringing under the definite calculations of any mechanical law, those mighty combinations still going on in the great laboratory of nature.

Of the origin of volcanic forces we know nothing : but we do know that they are the irregular secondary results of great masses of matter obeying the primary laws of atomic action—that they differ in their intensity—are interrupted in their periods—and are aggravated or constrained by an endless number of causes, external and purely mechanical. Of all modes of material combination, those of which I now speak are perhaps the most complicated. To assume, then, that volcanic forces have not only been called into action at all times in the natural history of the earth, but also, that in each period they have acted with equal intensity, seems to me a merely gratuitous hypothesis, unfounded on any of the great analogies of nature, and I believe also unsupported by the direct evidence of fact. This theory confounds the immutable and primary laws of matter with the mutable results arising from their irregular combination. It assumes, that in the laboratory of nature, no elements have ever been brought together which we ourselves have not seen combined ; that no forces have been developed by their combination, of which we have not witnessed the effects. And what is this but to limit the riches of the kingdoms of nature by the poverty of our own knowledge ; and to surrender ourselves to a mischievous, but not uncommon philosophical scepticism, which makes us deny the reality of what we have not seen, and doubt the truth of what we do not perfectly comprehend ?

Into the solution of the great problem of the heavenly bodies, there enter only a few simple and unchangeable mechanical elements, and the conclusions are of a simplicity corresponding to the simplicity of the premises. All the celestial movements return into themselves ; and even the most complex of the deviations produced by mutual perturbation, are confined within narrow limits, and are completed in secular periods. The solution of this problem is incontestably the greatest triumph of exact science. But with what semblance of physical truth can we apply such mathematical results as these to the great phenomena of geology—where the combinations are mutable and indefinite—where we have no vestige of returning periods—and where the fixed elements of force are either unknown or imperfectly comprehended ?

If all the complex groups of crystalline and stratified rocks ; if, in a word, all the material things existing on the surface of the

globe, be bound to each other by laws like those which govern the movements of the heavenly bodies—*then* every material combination we now see must re-appear with all its complicated relations after the lapse of some long period of time. But would not such a supposition be now regarded as the mere wantonness of hypothetical extravagance? And let it not be said, that it is only in the greater combinations on the surface of the earth that we are to look for returning cycles. Great and small have no meaning, except in reference to us and our conceptions. The earth is an atom in comparison with the visible creation; and all we now behold may be but as an atom in comparison of that which is unseen; and the meanest combinations of material things submitted to our senses propagate their influence through all space co-extensive with gravitation, and play their part in keeping up the stability of the universe.

To the supreme Intelligence, indeed, all the complex and mutable combinations we behold, may be but the necessary results of some simple law, regulating every material change, and involving within itself the very complications, which we, in our ignorance, regard as interruptions in the continuity of Nature's work. In contemplations of this kind our understanding is lost among the stern doctrines of philosophical necessity. But, as far as regards us and our faculties, there is no such thing on earth as undeviating moral or physical necessity. For as, in morals, necessity is made, in part, at least, subordinate to the freedom of human will; so, in physics, the continued action of immutable causes may and does co-exist with inmutable phenomena.

The study of the great physical mutations on the surface of the earth is the business of geology. But who can define the limits of these mutations? They have been drawn by the hand of Nature, and may be studied in the record of her works—but they never have been, and never will be fixed, by any guesses of our own, or by any trains of *a priori* reasoning, based upon hypothetical analogies. We must banish all *a priori* reasoning from the threshold of our argument; and the language of theory can never fall from our lips with any grace or fitness, unless it appear as the simple enunciation of those general facts, with which, by observation alone, we have at length become acquainted.

I should not have detained you one moment in enunciating propositions such as these, had I not believed that their true import had been partially misunderstood, and their spirit sometimes violated in a recent work on the "Principles of Geology." Before I proceed with this remark, let me, however, first discharge a debt of gratitude to the author, which, as yet, remains unpaid. Were I to tell him of the instruction I received from every chapter of his work, and of the delight with which I rose from the perusal of the whole, I might seem to flatter rather than to speak the language of sober criticism; but I should only give utterance to my honest sentiments. His work has already taken, and will long maintain a distinguished place in the philosophic literature of this country; higher praise than this I know not how to offer; and



when, by publishing another volume (for which we all look with earnest anticipation), he shall have recorded his discoveries in a field of observation, almost his own ; he will then have reaped the honour of being the first writer in our country to make known a general system of "geological dynamics,"—a new province gained by the advance of modern science.

But Mr. Lyell appears not only as the historian of the natural world, but as the champion of a great leading doctrine of the Huttonian hypothesis : and it is to the effects produced on the principles of his work by the latter character, that I now wish to call your attention, with all the freedom belonging to fair discussion and the love of truth. It would, indeed, be a strange anomaly in the history of physics, if the Huttonian hypothesis, framed by its distinguished author, without any knowledge of the most important facts of secondary geology, should require no new adjustments,—no limitation of its principles during the progress of discovery. I cannot but regret, that from the very title-page of his work, Mr. Lyell seems to stand forward as the defender of a theory. An hypothesis is indeed (when we are all agreed in receiving it) an admirable means of marshalling scattered facts together, and exhibiting them in all the strength of combination. But by those who differ from us, an hypothesis will ever be regarded with just suspicion ; for it too often becomes, even in spite of our best efforts, like a false horizon in astronomy, and vitiates all the great results of our observations, however varied, or many times repeated.

It cannot, I think, be doubted, that in the general statement of his results, Mr. Lyell has, unconsciously, been sometimes warped by his hypothesis, and that, in the language of an advocate, he sometimes forgets the character of an historian. In reading his graphic and eloquent descriptions of the mighty works of degradation yearly going on through the eastern shores of England, or of the enormous weight of solid matter hourly rolled down by the Ganges or the Mississippi, I have fancied that the earth was sliding from under my feet, and that it would soon pass away, like the sand of an hour-glass, beneath the waters of the ocean.

But are there no antagonist powers in nature to oppose these mighty ravages—no conservative principle to meet this vast destructive agency ? The forces of degradation very often of themselves produce their own limitation. The mountain torrent may tear up the solid rock, and bear its fragments to the plain below : but there its power is at an end, and the rolled fragments are left behind to a new action of material elements. And what is true of a single rock is true of a mountain chain ; and vast regions on the surface of the earth, now only the monuments of spoliation and waste, may hereafter rest secure under the defence of a thick vegetable covering, and become a new scene of life and animation.

It well deserves remark, that the destructive powers of nature act only upon lines, while some of the grand principles of conservation act upon the whole surface of the land. By the processes of vegetable life, an incalculable mass of solid matter is absorbed,

year after year, from the elastic and non-elastic fluids circulating round the earth, and is then thrown down upon its surface. In this single operation, there is a vast counterpoise to all the agents of destruction. And the deltas of the Ganges and the Mississippi are not solely formed at the expense of the solid materials of our globe, but in part, and I believe also in a considerable part, by one of the great conservative operations by which the elements are made to return into themselves.

Let me not, however, be misunderstood. I am not denying the great processes of degradation so admirably described by Mr. Lyell; but I contend that to estimate their whole effects is a problem of such complexity, and so variable in its conditions, that its true nature is not fairly placed before the mind by the mere enumeration of a few extreme cases, or the description of a few striking instances. If I were to speculate upon the method of solving this problem, I should compare it to the summation of a converging series—the successive terms of degradation may be infinite, but the whole result may still perhaps be limited and finite.

It is impossible for me now to grapple with Mr. Lyell's whole argument; but it appears to me, that volcanic action is not the only true conservative principle, and is rather to be regarded as the great productive principle, by which the solid matter on the surface of the globe has been lifted above the waters: and that the grand principles of conservation are to be looked for among the operations of the elements themselves, assisted by the combined action of animal and vegetable life.

According to the principles of Mr. Lyell, the physical operations now going on, are not only the type, but the measure of intensity of the physical powers acting on the earth at all anterior periods: and all we now see around us is only the last link in the great chain of phenomena, arising out of a uniform causation, of which we can trace no beginning, and of which we see no prospect of the end. And in all this, there is much that is beautiful and true. For we all allow, that the primary laws of nature are immutable—that all we now see is subordinate to those immutable laws—and that we can only judge of effects which are past, by the effects we behold in progress. Whether there be, or be not, any physical traces of a state of things anterior to the commencement of our geological series of deposits, is a question of no real importance. But to assume that the secondary combinations arising out of the primary laws of matter, have been the same in all periods of the earth, is, I repeat, an unwarrantable hypothesis with no *a priori* probability, and only to be maintained by an appeal to geological phenomena.

If the principles I am combating be true, the earth's surface ought to present an indefinite succession of similar phenomena. But as far as I have consulted the book of nature, I would invert the negative in this proposition, and affirm, that the earth's surface presents a definite succession of dissimilar phenomena. If this be true, and we are all agreed that it is; and if it be also true, that we know nothing of second causes, but by the effects they have produced; then,

“the undeviating uniformity of secondary causes,”—the “uniform order of physical events,”—“the invariable constancy in the order of nature,” and other phrases of like kind, are to me, as far as regards the phænomena of geology, words almost without meaning. They may serve to enunciate the propositions of an hypothesis; but they do not describe the true order of nature\*.

Each formation of geology may have required a very long period for its complete development; and of such an element as past time, we grudge no man the appropriation. But after all, the successive formations, about which we speculate, however complex in their subdivisions, are small in number: and after deciphering a series of monuments, we reach the dark ages of our history, when, having no longer any characters to guide us, we may indulge at will in the creations of our fancy. We may imagine indefinite cycles, and an indefinite succession of phænomena; and in the physical world, as well as in the moral, we may have our long periods of fabulous history. But these things belong not to inductive geology; and all I now contend for is—that in the well established facts brought to light by our investigations, there is no such thing as an indefinite succession of phænomena.

I will not, even in imagination, travel with you over the successive formations of the earth, or point out their mineralogical distinctions; but I may remind you, that in the very first step of our progress we are surrounded by animal and vegetable forms, of which there are now no living types. And I ask, have we not in these things some indication of change and of an adjusting power altogether different from what we commonly understand by the laws of nature? Shall we say with the naturalists of a former century, that they are but the sports of nature? Or shall we adopt the doctrines of spontaneous generation and transmutation of species, with all their train of monstrous consequences? These subjects, indeed, are not yet touched upon by Mr. Lyell; and I throw out these remarks only to show by what difficulties the Huttonian hypothesis is encountered—of a kind, too, never present to the mind of its inventor.

There is however one chapter in the “Principles of Geology” where the author combats the doctrine of the progressive development of organic life, and briefly considers the distribution of fossil bodies in the successive strata of the earth. I admit the general truth of his facts and the strength of his argument, and I allow that he has succeeded in exposing some of the errors and misstatements of his opponents. A doctrine may however be abused, and yet contain many of the elements of truth. With reference to the functions of the individual being, one organic structure is as perfect as another. But I think that in the repeated and almost entire changes of organic types in the successive formations of the earth—in the absence of mammalia in the older, and their very rare appearance (and then in forms entirely unknown to us) in the newer secondary groups—in the diffu-

\* Principles of Geology, p. 75, 76, 86, &c. &c.

sion of warm-blooded quadrupeds (frequently of unknown genera) through the older tertiary systems—in their great abundance (and frequently of known genera) in the upper portions of the same series—and, lastly, in the recent appearance of man on the surface of the earth (now universally admitted)—in one word, from all these facts combined, we have a series of proofs the most emphatic and convincing,—that the existing order of nature is not the last of an uninterrupted succession of mere physical events derived from laws now in daily operation : but on the contrary, that the approach to the present system of things has been gradual, and that there has been a progressive development of organic structure subservient to the purposes of life.

Considered as a mere question of physics, (and keeping all moral considerations entirely out of sight,) the appearance of man is a geological phenomenon of vast importance, indirectly modifying the whole surface of the earth, breaking in upon any supposition of zoological continuity, and utterly unaccounted for by what we have any right to call the laws of nature.

If by the laws of nature we mean only such manifestations of power as seem good to the supreme Intelligence, then there can be no matter for dispute. But in physical questions such terms as the “laws of nature” have a proper reference only to second causes : and I ask, by what operation of second causes can we account for the recent appearance of man? Were there no other zoological fact in secondary geology, I should consider this, by itself, as absolutely subversive of the first principles of the Huttonian hypothesis.

If the principles vindicated in Mr. Lyell’s work be true, then there can be no great violations of continuity either in the structure or position of our successive formations. But we know that there are enormous violations of geological continuity : and though relatively speaking many of them may be local, of this at least we are certain, that they have been produced by forces adequate to the effects and coextensive with the phenomena.

The very first step we take, we see a violation of continuity. Between the alluvial silt, deposited by the waters now flowing off from the inequalities of the earth, and the masses of diluvial gravel scattered over so many parts of its surface, we can seldom establish any appearance of continuity, or give any intelligible proof of their common origin. I am not going now to plunge into this long debated question ; but I may remind you of the enormous waterworn blocks (derived from the primary chains to the north of the Baltic Sea), which lie scattered over the great European plain, extending from the eastern states of Holland to the Steppes of central Russia. Where are the inclined planes down which these boulders could have descended? Where are the grooves and channels cut out by the rivers which once propelled them? Where is the alluvial silt accumulated by the erosion of these ideal waters? No answer can be given to these questions : and to talk of river action, aided as it may have been by every ordinary power of nature, appears to me, in a case like this, little better than a mockery of my senses.

Hundreds of instances leading to a like conclusion (on a less scale indeed, and therefore perhaps the less impressive,) may be found among the phenomena of our island\*.

If indeed we were to admit a period of intense volcanic violence, and a sudden elevation of the Scandinavian chain, we might then have a cause commensurate to the effects observed, and in the rush of the retiring waters we might explain the transport of those great boulders which lie scattered over the northern plains of Europe. But in the speculations I am combating, all great epochs of elevation are systematically, and I think unfortunately, excluded. Volcanic action is essentially paroxysmal; yet Mr. Lyell will admit no greater paroxysms than we ourselves have witnessed—no periods of feverish spasmodic energy, during which the very framework of nature has been convulsed and torn asunder. The utmost movements that he allows are a slight quivering of her muscular integuments.

But if we have proofs of the violation of continuity among our most recent deposits, still more impressive are the proofs as we descend in the geological series. Every observer is aware that we often pass, without any intermediate gradations, from systems of strata which are horizontal, to other systems which are highly inclined. This is a fact independent of hypothesis; but it is now almost universally admitted, that the highly inclined strata have undergone a movement of elevation. Using then the language of this hypothesis (to say the least of it a convenient mode of describing the phenomena)—we affirm that the inclined strata have been elevated at a time anterior to the existence of the horizontal strata which abut against them, or rest upon their edges. And if the ages of the inclined and horizontal strata be defined, we also necessarily define the period of the elevation.

This kind of reasoning has for some years been familiar to the geologists of Europe. Mr. Webster endeavoured to prove that the Isle of Wight had been upset after the period of the London clay, and before that of the lacustrine rock marl. Every one now admits, (and indeed it is made the foundation of one of the classifications of Mr. Conybeare,) that our carboniferous chains were elevated before the period of the new red sandstone.

But the researches of M. Élie de Beaumont, to which I now wish to direct your attention, have given a vast extension to the observations of all those who had gone before him. And before I proceed I cannot but lament that persons, who have not perhaps comprehended the meaning of this admirable observer, should have nibbled at the originality of his discoveries; as if the very essence of philosophical discovery did not often consist in bringing to a point all the scattered lights of former observations, and giving generalization to insulated phenomena.

\* The diluvial phenomena of this country are so well known, that it is perhaps unnecessary to appeal to them: but I wish to refer the reader to the papers of Sir James Hall (published in the *Edinburgh Transactions*), for some very remarkable proofs of the action of diluvial currents in the neighbourhood of Edinburgh.

In the first place then, by an incredible number of well conducted observations of his own, combined with the best attested facts recorded by other observers, he has proved, on the principles already pointed out—that whole mountain chains have been elevated at one geological period—that great physical regions have partaken of the same movement at the same time—and that these paroxysms of elevatory force have come into action at many successive periods. Distinguished as are his merits, he so far claims not an undivided honour. But in the next great step of generalization he reaches a position where he stands entirely by himself.

Step by step we had been advancing towards the conclusion—that different mountain chains had been elevated at several distinct geological periods: and by a long series of independent observations, Humboldt, Von Buch, and other great physical geographers, had proved—that the mountain chains of Europe might be separated into three or four distinct systems; distinguished from each other, if I may so express myself, by a particular physiognomy, and, above all, by the different angles made by the bearings of their component formations with any assumed meridian. All the subordinate parts of any one system were shown to be parallel; while the different systems were inclined at various angles to each other.

By an unlooked-for and most felicitous generalization, M. Élie de Beaumont has now proved that these two great classes of facts are commensurate to each other; and that each of these great systems of mountain chains, marked on the map of Europe by given parallel lines of direction, has also a given period of elevation, limited and defined by direct geological observations. The steps by which he reaches this noble generalization are so clear and convincing, as to be little short of physical demonstration. It forms an epoch in the history of our science; and I am using no terms of exaggeration when I say, that in reading the admirable researches of M. de Beaumont I appeared to myself, page after page, to be acquiring a new geological sense, and a new faculty of induction: and I cannot express my feelings of regret, that during my recent visit to the Eastern Alps I did not possess this grand key to the mysteries of nature.

I am aware how impossible it is in a few words to give any clear notion of a volume of condensed original researches. Dropping all minor details, I may, however, claim your indulgence while I point out the author's manner of induction in four great systems of European chains: not indeed in the wish of quenching the curiosity of those who have not studied this question, but rather in the hope of urging them to seek the fountain of original information.

1. The first system includes the higher elevations, in eastern France, of the Côte d'Or and Mont Pilas, and a portion of the Jura chain. It may be traced towards the valley of the Rhine, where it is suddenly cut off; but it reappears in the chain of the Erzgebirge, between Bohemia and Saxony. It never rises into mountains of the first order, but is marked throughout (as may be seen on a good physical map) by many longitudinal ridges and furrows, ranging nearly parallel to each other in a direction about north-east and south-

west. So far the statement is only an enumeration of certain connected facts in physical geography. But it is followed by a coordinate series of geological phenomena.

A number of formations, including in the ascending order the whole oolitic series, enter here and there into the composition of the geographical system above described; and without exception, wherever they appear, all are in turn elevated, broken, or contorted; yet in their lines of range they preserve a parallelism to the general direction of the ridges. On the contrary, wherever rocks of an age not older than that of the green-sand or chalk, appear in the vicinity of any portion of this system, they are either found at a dead level and expanded from the neighbouring mountains into horizontal planes, like the sea at the base of a lofty cliff; or if, since their first deposit, they have undergone any great movement, it is shown to have no relation to the bearing of the older ridges, and to have been produced at a later period.

From all these combined facts follow three important consequences. 1st, That the whole system of parallel ridges, from one end to the other, was elevated at the same period of time, after the development of the oolitic series, and before the deposition of the green-sand and chalk. 2ndly, That the action of elevation was violent and of short continuance; for the inclined strata are shattered and contorted, and between them and the horizontal strata there is no intermediate gradation of deposits. 3rdly, That the period of elevation was followed by an immediate change in many of the forms of organic life.

2. The next great system includes the whole chain of the Pyrenees—the Northern Apennines—the calcareous chains to the north-east of the Adriatic—nearly the whole Carpathian chain—and a great series of inequalities, continued from that chain through the Hartz mountains to the plains of Northern Germany. Through the whole of these vast regions the principal inequalities range nearly parallel to each other, and have a mean bearing about west-north-west and east-south-east. So far again the statement is purely geographical, and its truth is seen at once in glancing over any good physical map of Europe; and will be still more clearly comprehended, by comparing some of the principal ranges of colour on Von Buch's great geological map with the bearing of the Pyrenees. But it is followed by a series of co-extensive geological phenomena.

Through all parts of this great system, formations of the age of the green-sand and chalk have had an enormous development, and without exception, their strata are ruptured and contorted, and often lifted up to the very pinnacles of the mountains. But on the contrary, wherever any tertiary formations approach the confines of this system, they are stated to be either in a position almost as horizontal as the surface of the waters in which they were deposited; or if they have been moved at all, it is by forces uninfluenced by the parallels of the older chains. And the same three conclusions, with a mere difference of dates, follow here as in the former case. All the great parallel ridges and chains of this second system must have been suddenly and violently elevated, and at a period of time between the deposition of

the chalk and the commencement of the tertiary groups; and the corresponding change in organic types is, in this instance, still more striking than in the former.

3. The third system embraces a great number of parallel inequalities, bearing about north-north-east and west-south-west, and includes the whole Western Alps, from the neighbourhood of Marseilles to the volcanic ridges near the foot of the Lake of Constance. And by an hypothetical, but I think probable extension, it also takes in the whole of the great Scandinavian chain.

I cannot enter on the elaborate and satisfactory details by which it is proved—that all these great parallel inequalities in the region of the Western Alps had their origin after the tertiary *molasse*, a deposit partaking of all the elevations and contortions of the older strata—that the elevatory movements were sudden and violent, and commenced at a time when tribes of mammalia (the remains of which in England are hardly ever found except in the superficial gravel) flourished in many parts of Europe—and that these movements were immediately succeeded by great horizontal deposits of old diluvial gravel at the base of the Western Alps, and probably also by that vast offshot of Scandinavian rocks which lie scattered over the northern plains of Germany.

4. The fourth system embraces many great parallel ridges having a range about east-north-east and west-south-west, and includes several considerable chains in Provence, and nearly the whole chain of the Eastern Alps—from the great flexure in the region of Mont Blanc to the Alps of the states of Austria.

It would be impossible to follow the author through details occupying a large portion of his volume. I may however state, that he proves the formations of the Eastern and Western Alps not to pass into each other by any flexure of the strata coinciding with the bend of the whole chain; but to meet at an angle marked by a great double system of breaks and fissures, one passing in the direction of the eastern, and the other of the western portions of the chain. He further proves, that the system of fissures in the line of the Eastern Alps is more recent than the other system—that in the prolongation of this line towards the west, the old diluvial gravel has undergone movements of elevation—and that these movements have been propagated to the lacustrine and volcanic regions of Auvergne.

On a review of the whole evidence, I think he has demonstrated, that there are two distinct deposits of diluvial gravel near a portion of the Western Alps—that the colossal mass of Mont Blanc, and at least a considerable portion of the Eastern Alps, were elevated after the deposit of the older diluvium—and that the newer diluvium (including all those enormous crystalline erratic blocks so admirably described by Saussure) rolled off from the regions of the higher Alps during this last period of their elevation.

There are six other supposed periods of elevation briefly considered in the researches of M. Elie de Beaumont, each marked by distinct geographical features: but I will not now detain you with their enumeration. If the generalizations to which I have pointed be true, and, as far as I comprehend them, they seem to be based on an im-



moveable mass of evidence, we must then conclude that there have been in the history of the earth long periods of comparative repose, during which the sedimentary deposits went on in regular continuity, and comparatively short periods of violence and revolution, during which that continuity was broken. And if we admit that the higher regions of the globe have been raised from the sea by any modification of volcanic force, we must then also admit that there have been several successive periods of extraordinary volcanic energy.

How we are to escape from this conclusion I am unable to comprehend, unless we shut out the evidence of our senses. Of volcanic powers we know nothing, except during the irregular periods of their activity—and returning periods of intense activity, after long ages of comparative repose, may be among the enduring principles in the mechanism of nature. I do not throw this out as even a probable hypothesis; but it is, at least, as probable as any other hypothesis unfounded on the evidence of geological phenomena.

That the system of M. Élie de Beaumont is directly opposed to a fundamental principle, vindicated by Mr. Lyell, cannot admit of doubt. And I have decided to the best of my judgement, in favour of the former author, because his conclusions are not based upon any *a priori* reasoning, but on the evidence of facts; and also, because, in part, they are in accordance with my own observations\*.

Let me not, however, be misunderstood. I have been offering no general criticism of Mr. Lyell's work: I have merely been arguing against the extension of one hypothetical principle (an important one indeed in the interpretation of geological phenomena) on which we differ in opinion. Nineteen twentieths of his work remain untouched by these remarks. His excellent and original historic narrative—his dignified philosophic views and clear descriptions—his admirable account of the effects brought about by the great causes, whether aqueous or igneous, now acting on the crust of the globe, contribute to make his volume, in the highest degree, both popular and instructive; and I cannot but express a wish, that, in the future editions of his work, the system of "geological dynamics" may be stripped of even the semblance of hypothetical assumption; and that having first ascertained by a mere appeal to facts, what the powers of nature now are (and I know no one more competent to the task), he will then proceed to apply them to the solution of the dark problems of geology. This arrangement would not only be the most fair and logical, but would take away that controversial character, by which, in my opinion, some pages of his present volume are disfigured; and would, in the end, give him incomparably the best

\* For example; the vertical position of the green-sand and chalk on the eastern flank of the Hartz mountains, and the horizontal position of the same formations on the flanks of the Erzgebirge, were remarked by Mr. Murchison and myself in the summer of 1829. During the same tour we had repeated proofs of the recent elevation of the chain of the Eastern Alps; of the high elevation of the green-sand series in the calcareous chain to the north-east of Trieste; and of the horizontality of the tertiary deposits of Styria. All these facts (of which we did not at the time comprehend the whole importance) harmonize with the system of M. de Beaumont.

chance, either of limiting or extending his own principles, as might seem good during the advances of our science. What he has written with so much power, must inevitably produce a great impression on the English school of geology. It is on this account, and not with any spirit of unfriendly criticism, that I have discussed, at greater length than I first intended, the points on which we differ; and I am only anxious, that a work abounding in so many admirable details, should hereafter appear, as far as any human production can do, without a blemish in the enunciation of a single principle.

Greatly as I admire the generalizations of M. de Beaumont, they have, I think, been already pushed too far. We may follow them as our guides, but they must never take the place of direct observations. It is only through limited regions of the earth that we shall perhaps be ever able to make out the true parallels of contemporaneous elevation. Distant continents may have independent parallel systems of elevation. In several mountain chains (for example, in the Eastern Alps) we have direct proof, that the forces of elevation have acted on the same line at successive epochs; and in our island, there have been movements of elevation at different epochs, yet on lines which are parallel. Lastly, lines of elevation (like the existing lines of modern volcanic vent) may, in their prolongation, have deflected far from their first direction. But I must forbear, for the discussion of these questions would lead me into endless details\*.

At our former Anniversary I ventured to affirm, that our diluvial gravel was probably not the result of one, but of many successive periods. But what I then stated as a probable opinion, may, after the Essays of M. de Beaumont, be now advanced with all the authority of established truth: and among the many obligations we owe to this accomplished observer, I may mention the new and instructive views he has given us of the origin of the great masses of old detritus lying scattered over the lower regions of the earth. We now connect the gravel of the plains with the elevation of the nearest system of mountains; we believe that the Scandinavian boulders in the North of Germany are of an older date than the diluvium of the Danube; and we can prove, that the great erratic blocks, derived from the granite of Mont Blanc, are of a more recent origin than the old gravel in the tributary valleys of the Rhone. That these statements militate against opinions, but a few years since held almost universally among us, cannot be denied. But theories of diluvial gravel, like

\* That part of the generalizations of M. Élie de Beaumont, in which he seems to assume, that each great period of elevation was followed by a great change in organic forms, is, perhaps, the least secure. In England, there is a great break between the greywacké and carboniferous systems; yet the fossils, in the calcareous groups, alternating with the greywacké, very nearly approach to those of the carboniferous limestone. There is also a great break between the carboniferous and magnesian limestone series of this country; but their suites of fossils very nearly resemble each other, and several species are common to both. Again, on the outskirts of the calcareous zone of the Alps, there are large groups of strata, with fossils conforming both to the secondary and tertiary type. I must, however, add, in justice to the author, that his observations on the changes of organic forms, are casually thrown out, here and there, and do not seem to form any essential portion of his theory.

all other ardent generalizations of an advancing science, must ever be regarded but as shifting hypotheses to be modified by every new fact, till at length they become accordant with all the phenomena of nature.

In retreating where we have advanced too far, there is neither compromise of dignity nor loss of strength ; for in doing this, we partake but of the common fortune of every one who enters on a field of investigation like our own. All the noble generalizations of Cuvier, and all the beautiful discoveries of Buckland, as far as they are the results of fair induction, will ever remain unshaken by the progress of discovery. It is only to theoretical opinions that my remarks have any application.

Different formations of solid rock, however elevated and contorted, can never become entirely mixed together ; and the very progress of degradation commonly lays bare all the elements of their structure. But diluvial gravel may be shot off from the flanks of a mountain chain, during one period of elevation, and become so confounded with the detritus of another period, that no power on earth can separate them : and every subsequent movement, whether produced by land floods or any other similar cause, must continually tend still further to mingle and confound them. The study of diluvial gravel is, then, not only one of great interest, but of peculiar difficulty and nice discrimination : and in the very same deposit, we may find the remains of animals which have lived during different epochs in the history of the earth.

Bearing upon this difficult question, there is, I think, one great negative conclusion now incontestably established — that the vast masses of diluvial gravel, scattered almost over the surface of the earth, do not belong to one violent and transitory period. It was indeed a most unwarranted conclusion, when we assumed the contemporaneity of all the superficial gravel on the earth. We saw the clearest traces of diluvial action, and we had, in our sacred histories, the record of a general deluge. On this double testimony it was, that we gave a unity to a vast succession of phenomena, not one of which we perfectly comprehended, and under the name diluvium, classed them all together.

To seek the light of physical truth by reasoning of this kind, is, in the language of Bacon, to seek the living among the dead, and will ever end in erroneous induction. Our errors were, however, natural, and of the same kind which led many excellent observers of a former century to refer all the secondary formations of geology to the Noachian deluge. Having been myself a believer, and, to the best of my power, a propagator of what I now regard as a philosophic heresy, and having more than once been quoted for opinions I do not now maintain, I think it right, as one of my last acts before I quit this Chair, thus publicly to read my recantation.

We ought, indeed, to have paused before we first adopted the diluvian theory, and referred all our old superficial gravel to the action of the Mosaic flood. For of man, and the works of his hands, we have not yet found a single trace among the remnants of a former world entombed in these ancient deposits. In classing together di-

stant unknown formations under one name ; in giving them a simultaneous origin, and in determining their date, not by the organic remains we had discovered, but by those we expected hypothetically hereafter to discover, in them ; we have given one more example of the passion with which the mind fastens upon general conclusions, and of the readiness with which it leaves the consideration of unconnected truths.

Are then the facts of our science opposed to the sacred records ? and do we deny the reality of a historic deluge ? I utterly reject such an inference. Moral and physical truth may partake of a common essence, but as far as we are concerned, their foundations are independent, and have not one common element. And in the narrations of a great fatal catastrophe, handed down to us, not in our sacred books only, but in the traditions of all nations, there is not a word to justify us in looking to any mere physical monuments as the intelligible records of that event : such monuments, at least, have not yet been found, and it is not perhaps intended that they ever should be found. If, however, we should hereafter discover the skeletons of ancient tribes, and the works of ancient art buried in the superficial detritus of any large region of the earth ; then, and not till then, we may speculate about their stature and their manners and their numbers, as we now speculate among the disinterred ruins of an ancient city.

We might, I think, rest content with such a general answer as this. But we may advance one step further—History is a continued record of passions and events unconnected with the enduring laws of mere material agents—The progress of physical induction, on the contrary, leads us on to discoveries, of which the mere light of history would not indicate a single trace. But the facts recorded in history may sometimes, without confounding the nature of moral and physical truth, be brought into a general accordance with the known phenomena of nature : and such general accordance I affirm there is between our historical traditions and the phenomena of geology. Both tell us in a language easily understood, though written in far different characters, that man is a recent sojourner on the surface of the earth. Again, though we have not yet found the certain traces of any great diluvian catastrophe which we can affirm to be within the human period ; we have, at least, shown, that paroxysms of internal energy, accompanied by the elevation of mountain chains, and followed by mighty waves desolating whole regions of the earth, were a part of the mechanism of nature. And what has happened, again and again, from the most ancient, up to the most modern periods in the natural history of the earth, may have happened once during the few thousand years that man has been living on its surface. We have therefore, taken away all anterior incredibility from the fact of a recent deluge ; and we have prepared the mind, doubting about the truth of things of which it knows not either the origin or the end, for the adoption of this fact on the weight of historic testimony.

If, Gentlemen, I believed that the imagination, the feelings, the active intellectual powers bearing on the business of life, and the highest capacities of our nature, were blunted or impaired by the

study of our science, I should then regard it as little better than a moral sepulchre, in which, like the strong man, we were burying ourselves and those around us, in ruins of our own creating. But I believe too firmly in the immutable attributes of that Being, in whom all truth, of whatever kind, finds its proper resting place, to think that the principles of physical and moral truth can ever be in lasting collision. And as all the branches of physical science are but different modifications of a few simple laws, and are bound together by the intervention of common objects and common principles; so also, there are links (less visible, indeed, but not less real) by which they are also bound to the most elevated moral speculations.

At every step we take in physics, we show a capacity and an aptency for abstract general truth; and in describing material things, we speak of them, not as accidents, but as phænomena under the government of laws. The very language we use (and it is hardly possible for us to explain our meaning by any other), is the language in which we describe the operations of intelligence and power. And hence we admit, by the very constitution of our intellectual nature, and even in spite of ourselves, an *anima mundi* pervading all space, existing in all times, and under all conditions of being.

But we do not stop here; for the moment we pass on to that portion of matter, which is subservient to the functions of life, we there find all the phænomena of organization: and in all those beings the functions of which we comprehend, we see traces of structure in many parts as mechanical as the works of our own hands, and, so far, differing from them only in complexity and perfection; and we see all this subservient to an end, and that end accomplished. Hence, we are compelled to regard the *anima mundi* no longer as a uniform and quiescent intelligence, but as an active and anticipating intelligence: and it is from this first principle of final causes, that we start with that grand and cumulative argument, derived from all the complex functions of organic nature.

Geology lends a great and unexpected aid to the doctrine of final causes; for it has not merely added to the cumulative argument, by the supply of new and striking instances, of mechanical structure adjusted to a purpose and that purpose accomplished; but it has also proved that the same pervading active principle, manifesting its power in our times, has also manifested its power in times long anterior to the records of our existence.

But after all, some men seeing nothing but uniformity and continuity in the works of nature, have still contended (with what I think a mistaken zeal for the honour of sacred truth), that the argument from final causes proves nothing more than a quiescent intelligence. I feel not the force of this objection. In geology, however, we can meet it by another direct argument; for we not only find in our formations organs mechanically constructed—but at different epochs in the history of the earth we have great changes of external conditions, and corresponding changes of organic structure; and all this without the shadow of a proof that one system of things graduates into, or is the necessary and efficient cause of, the other. Yet in all these instances of change, the organs, as far as we can comprehend their use,

are exactly those which were best suited to the functions of the being. Hence we not only show intelligence contriving means adapted to an end, but at successive times and periods contriving a change of mechanism adapted to a change in external conditions. If this be not the operation of a prospective and active intelligence, where are we to look for it?

Our science is then connected with the loftiest of moral speculations; and I know no topic more fitting to the last sentiments I wish to utter from this Chair.

There is one way, and one way only, in which the higher intellectual powers may be cramped by the pursuit of natural truth, and that is by a too exclusive devotion to it. In the pursuit of any subject, however lofty, a man may become narrow-minded, and in a condition little better than that of moral servitude: but on this score we have not much to fear. Every department of science offers its spoils for our decoration; we are carried into regions where we contemplate the most glorious workmanship of Nature, and where the dullest imagination becomes excited; we are forced to travel through distant lands, and become familiar with the complexions, and the feelings, and the characters of mankind under every form of social life; and in doing this, if we be not most indocile learners, we must bear away lessons of kindness, and forbearance, and freedom of thought, along with the appropriate knowledge of our own vocation; and all this we can carry with us into the business of life. These, Gentlemen, are the high qualities which ought to form the ornament of this Society; and I am certain that I have seen their constant exercise in the intercourse and the discussions of this room, where mutual goodwill, frankness, and the love of truth, are the only dominant sentiments.

My own connexion with this Society during the two years I have had the honour to preside over its councils, has been to me a source of continued and heartfelt pleasure: and it would be with pain indescribable that I should now quit this Chair and bid you farewell, did I not think that I should very often meet the same friends, and partake in the same discussions.

Every man, whatever be his station, has a small circle of duties which are paramount to all others: but after these are performed, such powers as are given me shall ever be willingly devoted to your service. I do not mean this for empty boasting; that language would ill become me at any time, and least of all when I am leaving this Chair and descending into your ranks. Mine has been indeed but an interrupted service; but I resign it to one of whose powers you have had long experience, who can give them to you undivided, and whose hands are in no respect less ready than my own.

PROCEEDINGS  
OF  
THE GEOLOGICAL SOCIETY OF LONDON.

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1831.

No. 21.

March 2nd.—Robert McCallan, Esq. of Hampton Wick, Middlesex; the Very Reverend the Dean of Carlisle; and William Hawes, Esq. of Russell Square,—were elected Fellows of this Society.

A paper was first read “On the rippled markings of many of the forest marble beds north of Bath, and the *foot-tracks* of certain animals occurring in great abundance on their surfaces.” By George Poulett Scrope, Esq., F.G.S., F.R.S.

The wavy and wrinkled figuring of these and other sedimentary strata, the author considers to be identical in all its various accidents, as well as in its origin, with the markings of the sea-sands exposed at low tide on many of our shallow shores. He attributes it to the vibratory movement of the lower stratum of water, when agitated by winds or currents, by which sediment, either in the act of precipitation or stirred up from the bottom, is led to arrange itself in ridges corresponding to the intervals between the contiguous arcs of oscillation.

Since it cannot be supposed that such movements reach to any very considerable depths, these ripple-marks make it probable that the beds in which they occur were formed on a shallow shore; and this idea is further confirmed, and their analogy with the littoral deposits of our modern coasts brought still closer, by their composition of rolled fragments of shells, of corals, spines of echinus, and crustacea, by the imbedded remains of fuci, and above all by the frequent intersection of their surfaces by the sharp well-defined and fresh-looking *tracks of some small animal*, impressed upon the sand, apparently when left dry by the ebbing of the tide.

Here then, says the author, we have brought together in the compass of a small slab, several interesting memoranda of the day, however distant, when the waves of the ocean were beating against a line of coast now in the centre of our island; and a new class of facts to assist in better deciding the question as to the date of emergence of the different successive formations from the bosom of the deep.

Mr. Scrope does not hazard a conjecture respecting the genus or even the class to which the animal may have belonged; leaving it to zoologists to determine whether it be marine, terrestrial, or amphibious. He, however, earnestly recommends geologists in every quarter of the globe to examine minutely the surface of sandstones, and other sedimentary strata, particularly where ripple-

marked or alternating with clay seams (which effectually preserve the surface in all its original freshness), little doubting that the result will be to throw much new light on the early history of our planet, and on the habits and characters of its successive races of animated inhabitants.

The reading of a paper, entitled "A description of longitudinal and transverse sections through a portion of the carboniferous chain between Penigent and Kirkby Stephen," by the Rev. Adam Sedgwick, F.G.S., F.R.S., Woodwardian Professor in the University of Cambridge,—was begun.

March 16.—Henry Bickersteth, Esq., Fellow of Caius College Cambridge, and of Lincoln's Inn, London; and Charles Barclay, Esq. of Grosvenor Place, were elected Fellows of this Society.

The reading of the paper by the Rev. Professor Sedgwick, begun at the last Meeting, was concluded.

The author having in a former paper (read Jan. 5th, 1831) described some of the characters of the great central carboniferous chain of the North of England, here describes, in great detail, the composition of a very remarkable portion of it, which forms a connecting link between the structure of the High Peak of Derbyshire and the region of Cross Fell. The principal section, commencing at the top of Penigent in Hooton parish, passes over the highest mountains of the chain, and ends in the valley of the Eden, near Kirkby Stephen, among the conglomerates of the new red sandstone. From the top of Penigent and of Whernside, branch out two other sections connecting the mountains along the principal line, with those which range between Wensleydale and Swaledale. The successive groups of strata appearing along these lines are described in the ascending order, and their modifications in the successive valleys where they crop out are shortly noticed.

It is impossible to notice the seventeen groups enumerated in this paper; but they may be subdivided more simply into three principal groups as follows:

1st. Great scar limestone; the maximum thickness of which is more than 500 feet. The author compares this group with the limestone of the High Peak, and shows that they have many characters in common. He particularly notices the reciprocating wells and caverns, about the origin of which he briefly speculates. He notices the chief changes of mineralogical character; and states that among the very rare fossils of the mountain limestone, ammonites, Trilobites, and Orthoceratites, appear to be confined to this group. He further states, that although carbonaceous and bituminous matter are the colouring principle of the limestone strata in this group, there are no workable beds of coal subordinate to it on any of the lines of section.

2nd. The next great group comprehends no less than eleven groups of the author's sections, and in several mountains is more than 1000 feet in thickness. It is essentially composed of mountain limestone, sandstone, and shale. The limestone groups are stated to be five in number, and to be very remarkable for their regularity



in all the various sections: the lowest contains the black compact beds now extensively quarried in the North of England for marble; the highest group represents the twelve-fathom-limestone of the mining districts; it contains beds made up of an incredible number of encrinital stems, and is also quarried for marble. The shales are carbonaceous, and contain three or four beds of coal, some of which are of good quality, and are extensively worked for domestic use: the most remarkable of these beds occurs under the twelve-fathom-limestone.

3rd. The highest complex group includes all the deposits connected with the millstone grit, and is stated to be more than 500 feet in thickness. It includes three distinct deposits, to which the author gives the name of millstone grit; and several beds of carbonaceous shale, one of which contains a bed of coal three feet thick and of good quality. Besides this there are one or two other coal-beds, but of very inferior value, seen here and there along the lines of section.

After entering on many minute details, which it is impossible to notice in this abstract, the author describes five transverse sections, drawn nearly east and west from different points in the principal line of section across the prolongation of the great Craven fault, described in a former paper. By the help of these sections he points out the peculiar relative movements of the grauwacké and carboniferous chains during the period of elevation which preceded the new red sandstone. At the foot of Barfell, above Sedburgh, a mass of the carboniferous system, six or seven hundred feet in thickness, has been torn up from the foundations of the mountain and placed in an inverted position.

From all the previous details the author draws a series of conclusions, and shows:

1st. That the region described in the paper, forms a connecting link between the northern and southern ends of the carboniferous chain; and that the carbonaceous deposits are gradually more and more interlaced with the limestone in the range towards the north.

2ndly. That many of the coal-beds alternating with the mountain limestone must have been deposited in the waters of a deep sea; that no fresh-water shells appear associated with the fossils of these beds; and that the highest part of the Yorkshire coal-fields was probably deposited in shallow bays and estuaries, inasmuch as *Pecten* and *Ammonites* are there found associated with fresh-water genera.

3rdly. That, with limited exceptions, the same species of fossils are found in all the beds of limestone; but wherever there is a change of mineral character, that there we may remark an equally sudden change in the fossil species. Thus the vegetable impressions abounding in the sandstone and shale are not found in the limestone; on the contrary, the corallines, encrinites, &c. of the limestone, with rare exceptions, do not occur in the shale or sandstone beds.

4thly. That the beds of limestone appear to have been formed by

a slow and tranquil deposit, assisted by the action of organic bodies, which lived and died on the spots where they are now found; that on the contrary, the beds of shale and sandstone appear to have been formed mechanically, and contain fossils drifted from a distance. Hence these beds are less continuous and regular than the groups of limestone; but some of them, especially two of the coal-beds, may be traced through the greater part of the several lines of section.

5thly. That the valleys of the carboniferous chain, near the lines of section, are not excavated on lines of fault, but on true valleys of denudation. Notwithstanding this, there has been some change in the distribution of the water channels, at a period very recent, compared with that of the elevation of the carboniferous chain—just before the deposit of the new red sandstone.

March 30th.—Viscount Norreys, M.P., of John Street, Berkley Square; Sir John Johnstone, Bart. M.P., of Lower Grosvenor Street; Samuel Duckworth, Esq. of Trinity College, Cambridge, and Lincoln's Inn, London; William John Hamilton, Esq. of Stanley Grove, Chelsea; and Charles Hay Carnegy, M.D. of Edinburgh,—were elected Fellows of this Society.

A paper was read, entitled "Geological remarks on the vicinity of Swan River and *Isle Buêche* or Garden Island, on the coast of Western Australia;" by the Rev. Archdeacon Scott, F.G.S.

The author, who was accidentally detained for several months at the settlement recently established on the western side of Australia, describes a line of coast, of more than thirty miles in length, as composed of a highly calcareous sandstone, presenting very similar mineralogical characters throughout its whole extent. At a promontory, about five miles to the north of the river Swan, the calcareous sandstone exhibits a surface in which are numerous concretions having the appearance of inclosing vegetable matter. This character is by no means confined to that spot, but is very commonly observed; and on a rising ground, to the east of a space marked out for the intended town of Fremantle, the sandstone assumes the appearance of a thick forest, cut down about two or three feet from the surface, so that to walk on it becomes extremely difficult, and even dangerous.

The author gives a detailed account of the sections which accompany the paper, and notices the beds passed through in sinking various wells in the calcareous sandstone.

At Mount Eliza, which rises above Perth, ten miles from the mouth of the Swan, and the principal place in the settlement, the calcareous sandstone attains the height of about 300 feet, and is observed to be based upon a ferruginous sandstone fitted for the purposes of building. From Perth to the foot of Darling's Range, red clay and white marl are found after passing the Helena River. Darling's Range is estimated at about 1500 feet above the level of the sea, and is composed, where visited, of greenstone and sienite; and he was also informed that clay slate had been discovered more to the southward in the same range.

Isle Buâche, or Garden Island, consists of the same highly calcareous sandstone which forms so considerable a portion of this part of the Australian coast.

April 13.—The Rev. Henry Browne, A.M. Head Master of the London University School, was elected a Fellow of this Society.

A paper was read, dated at Sydney, New South Wales, 14th October, 1830, and entitled, "An Account of the limestone caves at Wellington Valley, and of the situation, near one of them, where fossil bones have been found:" by Major Thomas L. Mitchell, F.G.S., &c. Surveyor-General of New South Wales.

Wellington Valley is about 170 miles west of Newcastle on the eastern coast of Australia. It forms the ravine of the river Bell, one of the principal sources of the Macquarrie, which river it joins, below the places described in the paper, after a course of about six miles in a direct line from south to north; the Macquarrie itself at the point of junction running nearly from east to west, in its progress towards the swamps of the interior, where it disappears.

The rock, through which the valley has been excavated, is limestone, much resembling in external characters that of the carboniferous series of Europe. This appears on both sides of the valley above the alluvial deposits in the bottom, and extends on the east to the height of about 100 feet above the stream. On the west of the valley, hills of greater height run parallel to the limestone, consisting of a red sandstone and conglomerate; and a range of heights on the east of it is composed of trap rocks. The basis of a tract, still further eastward, which divides the watershed of the interior, from that which sends its streams to the sea, is granite.

The rugged surface of the limestone tract, in several parts of which the bare rocks are exposed, appears to abound in cavities, the orifices of caves and fissures; two of which, the more immediate subject of this communication, are about eighty feet above the stream of the Bell, on its eastern side; the first being a cave about 300 feet in extent; the second apparently a wide fissure in the limestone, partially filled up.

The Cave agrees in structure with many of those well known from the descriptions of Dr. Buckland and other writers: it descends, at first, with a moderate inclination; and about 125 feet from the mouth, the floor is thickly covered with a fine dry reddish dust, in which a few fragments of bones, apparently of kangaroos, occur. The cavern in different places affords beautiful stalactites and stalagmitic incrustations. Irregular cavities in the roof seem to lead towards the surface of the hill; and at the remotest part the floor is covered with a heap of dry white dust, so loose and light, that one of the exploring party sunk into it up to the waist. This dust, when chemically examined by Dr. Turner, was found to consist principally of carbonate of lime, with some phosphate of lime and animal matter. In fine, the cave appeared to terminate in a fissure nearly vertical, with water at its bottom, about thirty feet below the lowest part of the cavern, and nearly on a level with the waters of the river Bell. This fissure also extended upwards towards the surface.

About eighty feet to the west of the cave above described, is the mouth of another cavity of a different description, first examined by Mr. Rankin. At this place the surface itself consists of a breccia full of fragments of bones; and a similar compound confusedly mixed with large rude blocks of limestone, forms the sides of the cavity, which is a nearly vertical, wide, and irregular sort of well, accessible only by the aid of ladders and ropes. This breccia consists of an earthy red calcareous stone having small fragments of the grey limestone of the valley dispersed through it, and in some parts possesses considerable hardness. Near the lower part of the fissure (the whole extent of which was not explored) were three layers of stalagmitic concretion about two inches in thickness and three inches apart, the spaces being occupied with a red ochreous matter, with bones in abundance imbedded both in stalagmite and between the layers of it.

The bones found in the fissure just described, of which specimens have been sent to England, belong with only two exceptions, to animals at present known to exist in the adjacent country; and their dimensions also are very nearly the same with those of the existing quadrupeds. The species, from the report of Mr. Clift, to whose examination the bones were submitted, appear to be as follows: Kangaroo, Wombat, *Dasyurus*, Koala, *Phalangista*,—the most abundant being those of the Kangaroo. Along with the remains just mentioned were found two bones, not agreeing with those of any of the animals at present known to exist in New South Wales. The first and larger (of which a figure only accompanies this paper, the bone itself having been sent to Edinburgh) is supposed to belong to the Elephant: the second bone is also obscure and imperfect, but seems to be a part of one of the superior maxillary bones of an animal resembling the Dugong; it contains a portion of a straight tusk pointing directly forward.

A pit was dug, by Major Mitchell's direction, in the surface of the ground about twenty-five feet from the mouth of the fissure, at a place where no rocks projected; and the hill was there found to be composed of a hard and compact breccia, such as that described above, and abounding likewise in organic remains.

Other caverns containing a similar breccia occur in the limestone on the north bank of the Macquarrie, eight miles north-east of those at Wellington; and about fifty miles to the south-east, at Buree, are several caves like the first described above, which communicate with fissures partially occupied with breccia containing bones. At Molong, thirty-six miles to the east of Wellington, a small quantity of concreted matter has been found, containing numerous bones, of which no specimens have been sent to Europe; but the author remarks that, from their size, they would appear to have belonged to species larger than those which at present occupy the country.

In conclusion, the author states that he can offer no explanation of the facts he has mentioned; and he points to the great resemblance between the bony breccia of New South Wales, and that of the shores of the Mediterranean described by Major Imrie, in the Transactions of the Royal Society of Edinburgh.

April 27.—William Pyle Taunton, Esq., of Stoke Bishop, near Bristol, was elected a Fellow of this Society.

A paper was read, entitled, "On some effects of the atmosphere in wasting the surfaces of buildings and rocks:" by John Phillips, Esq. F.G.S., &c.

The remarks in this paper are restricted to the initial or preparatory processes by which earthy materials are provided for rivers and the sea to transport and deposit in new situations. These processes are considered by the author under several heads, according to their chemical and mechanical relations; but he observes that it is not always possible to distinguish accurately the effects of these several causes, which indeed are commonly concerned in the same operation.

The author, after stating some of the changes produced upon various rocks and buildings by the chemical agency of the gaseous elements of the atmosphere, illustrates the almost entire immunity from such alterations enjoyed by substances buried in the dry earth, by the remarkable perfection of sculpture, colour, and gilding, of the statues formerly placed in St. Mary's Abbey at York, which were recently discovered in digging the foundation of the Yorkshire Museum.

The more rapid waste of those parts of a building which are shaded by a projecting ledge, is compared with analogous effects upon detached blocks of stone (like the Buckstone near Monmouth), which by a further continuation of the process might be transformed into rock-ing-stones, as at Brimham Crags in Yorkshire. The rapid waste occasioned by fluctuations of heat and moisture is next examined; and it is shown that the south and west fronts of buildings suffer most by these variations; that when the composition of the stone is unequal, the waste of its surface corresponds in general to the nature and arrangement of the particles; but that also there are cases when the atmospheric influences cause an exfoliation of the surface, without reference to the internal arrangement of the particles. Thus, desquamation is observed to happen parallel to the ornamented surface of the sandstone balusters of a bridge at Durham, to the rounded face of the "flagstone" employed for curbstones at York, to the embossed tooling of the "molasse" used in the walls of Zurich, and to the west front of the magnesian limestone of a church in Yorkshire.

The power of frost in connection with other agents is then noticed as very important in producing the fall of mountain precipices; and the author concludes his paper with a description of some remarkable excavating effects of rain on the surfaces of ancient monumental stones and bare limestone rocks. He endeavours "to show, that within the historic æra hard and durable stones have been greatly furrowed by the rain, and that in more ancient periods the precipitations from above have carved themselves channels of various kinds, and sometimes occasioned real though miniature valleys of great length and continuity."

The first example of these rain channels is taken from the druidical stones of Boroughbridge, composed of millstone grit, called the Devil's Arrows; and it is shown that the rain beating upon these vene-

rable pillars, has cleft their tops and furrowed their sides, in the lines of quickest descent, without regard to the irregularities of their composition. One of the stones leans remarkably and threatens to fall; but an examination of the rain channels shows the inclination of the stone to be of most ancient date, for these descend further on the upper sloping face than on the under.

Stones which have fallen from the limestone cliffs of Switzerland have been furrowed by the rain since the time of their descent.

On Doward Hill near Monmouth, and still more in the broad surface of the crags around Ingleborough in Yorkshire, the effects of the rain on the weathered beds of limestone are evident and remarkable. But the most striking phænomena of the kind known to the author occur on Hutton roof crags near Kirby Lonsdale.

Hutton Roof Crags afford an opportunity of tracing the rain channels over an immense surface of bare limestone rocks, lying nearly level on the hill-top, but sloping rapidly down the sides to the east and south. On the level top of the hill the stones are variously worn in hollows and grooves, irregularly united and running in different directions, according to little inequalities of the ground; but on the steep slopes the channels are extended into long furrows, which, meeting at acute angles, enlarge, widen, and descend the hill-side in lines following exactly the declination of the rocks, and stopped only by the few and distant fissures, beyond which other systems of concurrent grooves begin.

PROCEEDINGS  
OF  
THE GEOLOGICAL SOCIETY OF LONDON.

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1831.

No. 22.

May 11th.—William Richardson, Esq. M.A. of Christ Church College, Cambridge, and Bedford Row, London, was elected a Fellow of this Society.

The reading of a paper entitled “Notes on the Secondary Formations of Germany, as compared with those of England,” by Roderick Impey Murchison, Esq. Pres.G.S. F.R.S. &c., was begun.

May 25th.—The Rev. Thomas Worsley, M.A. of Downing College, Cambridge; and the Rev. Robert Willis, M.A. of Caius College, Cambridge,—were elected Fellows of this Society.

The reading of the paper by Mr. Murchison, begun at the last Meeting, was concluded.

This communication is derived from a series of memoranda which the author has extracted from note-books, written as he passed through various parts of Germany in the last three years; and he presents it to the Geological Society in the hope, that it may rouse the attention of his countrymen to the increasing geological interest of that country, and to the various valuable native publications which describe its subdivisions. He endeavours to point out, in ascending order, all the German formations from the surface of the carboniferous rocks up to the newest tertiary deposits, showing, as far as is possible, their analogies and discrepancies when compared with those of England, and entering into detail on such points only as fell directly under his own observation. He refers for an account of places not visited by himself, to the general work of M. Boué, and to various local authorities.

In citing, with much praise, the recently published maps and sections of Hoffmann on North-Western Germany, the English inquirer is cautioned against the general application, in Germany, of that part of the table of superposition, in which the coal-measures are designated as some beds, subordinate to a vast thickness, 3000 or 4000 feet, of red sandstone and conglomerate, the whole of which are grouped by Hoffmann under the one term of *rothe-todte-liegende*. It is shown, on the contrary, that, however well this classification may apply to a small part of Germany, it is by no means the rule in the N.E. part of Bavaria, in Bohemia, and Westphalia; in all of which countries there are successions in the carboniferous series, very similar to those in England, accompanied with large expansions of mountain and transition limestones. The author, therefore, adopts that view of Professor Sedgwick which restricts the name of *rothe-todte-*

*legende* to those sandstones and conglomerates which surmount the carboniferous series, and separate it from the *kupfer-schiefer* and magnesian limestone.

In describing the *kupfer-schiefer* and overlying limestones, *zechstein*, &c. the author cites M. Klipstein's late work on the Wetterau and Spessart; and he confirms the conclusions already drawn by Prof. Sedgwick in his comparison and identification of the same strata with the magnesian limestone of England.

*New red sandstone series.*—In this vast group the author, following the classification of Humboldt, Hoffmann, and other modern writers, points out that in Germany it is divided into three great systems; an inferior and a superior red sandstone, each abounding in variegated marls, the one separated from the other by that great limestone formation called the *muschelkalk*. The lowest system or *bunter sandstein* being described first in general terms, detailed sections of it are then given from Alsace, where the author found it to be capped by *muschelkalk*, and charged with some peculiar plants, chiefly Coniferæ and Ferns, first discovered in it by M. Voltz, and since described by M. Adolphe Brongniart: he likewise found in it many bivalve and univalve shells, approaching very nearly in character to those of the *muschelkalk* and superior formations, but, as well as the plants, differing essentially from any fossils of the magnesian limestone and inferior formations. The frequent occurrence of salt and gypsum is noticed—numerous instances of great dislocations and elevations of the beds are enumerated, particularly on the northern flank of the Hartz—in the south of Hanover, a section across the Thuringerwald, by a new road, is given—and places are cited where the red sandstone is prismaticized, in contact with trappean or igneous rocks.

*Muschelkalk.*—This most important limestone formation, averaging in thickness from 600 to 800 feet, is seen in Wirtemberg, Bavaria, Gotha, and Hanover, to rest upon the *bunter sandstein*, and to be capped by *keuper*. A triple subdivision of the *muschelkalk*, established by Hausmann, is spoken of, in which each subdivision is characterized by its peculiar fossils.

For a full account of the *muschelkalk* of Wirtemberg the reader is referred to Alberti's *Königsreich's Würtemberg*, by which it is shown, that all the salt-mines of that kingdom occur in this formation. The Saurian remains found in it by M. Jäger consist of *Plesiosaurus*, *Ichthyosaurus*, and an unknown reptile; in addition to which Count Münster has procured from the same limestone the jaws and teeth of a crocodile, plates of a turtle, many parts of fishes of new genera, &c. By way of comparison with the *muschelkalk* of Germany, the author gives a sketch of the same formation in Lorraine, where the fine collection of M. Gaillardot of Luneville is specially spoken of, in which, in addition to many Saurian remains, there are bones of gigantic tortoises, with the characteristic fossils of the formation (*Ammonites nodosus*, *A. biplicatus*, *Mytilus socialis* (Schlot.), *Encrinites liliformis*), and two species of the remarkable fossil called Rhyncholites.

*Keuper.*—This formation of purple, red and green sandstone and marls is stated to be of enormous thickness at Stuttgart, where it is



seen reposing on *muschelkalk*, surmounted by lias; and a detailed section at that place is given, in which are specified the beds of red sandstone containing the greatest number of the fossil plants described by M. Jäger. Calamites are mentioned as being found in the lower quarries; and in the upper, certain Equisetaceous plants, which very much approach to the characters of the plants of the lias and oolitic series of England: 2 new species of Saurians (*Cylindricodon* and *Cubicodon* of Jäger) are also mentioned. The exact range of this formation in the north of Germany is to be found in Hoffmann's new maps.

The author believes that the upper red and green marls of the English series are the true representatives of the *keuper*, and that the only group in the red sandstone series of Germany hitherto unobserved in England, is the *muschelkalk*; and he invites geologists to attempt to discover the equivalent, however feeble, of that limestone formation, by seeking for it as a bed of separation between the upper red marls and the lower new red sandstone of this island.

*Lias*.—The lias marls and gryphite limestone, with many identical species of English fossils, are stated to be well developed in Wirtemberg, the north of Bavaria, Hanover, Westphalia, &c.

After instituting a close comparison between the fossil contents of the lias of Wirtemberg and that of England, in Saurian and other animal remains, drawn chiefly from the work of M. Jäger, the author gives in great detail, a section on the right bank of the Maine at Banz, near Coburg, a spot to which his attention was first directed by M. de Buch, where the beds are very analogous in mineral characters and succession to those of the coast of Whitby, and where the most astonishing profusion of fossils has been collected through the industry of MM. Theodori and Gezer, all of which now ornament the Ducal museum of Banz. Amongst these are 6 species of *Ichthyosaurus*, 5 of which are known in England (*Ichthyosaurus tenuirostris* being the most abundant):—Fishes, 6 or 7 genera, (*Dapedium*, *Clupæa*, *Cyprinus*, &c.)—*Pterodactylus*—Crustacea, 2 species, *Ammonites*, 11 species, of which about two-thirds are figured in Sowerby's *Mineral Conchology*—*Belemnites*, 12 species, *Scaphites*, *Nautili* and numerous other univalves as well as bivalves common to the English lias. Some of the higher beds are described as containing *Trochi*, *Helicinæ*, and *Spiriferæ*. *Pentacrinites Briareus* of the English lias is likewise stated to be of common occurrence, and that a species of *Fungia*, a genus of corals hitherto unobserved in the lias of England, also occurs.

*Inferior Oolite*.—The inferior oolite of Germany is next described, as being quite analogous to that of the Hebrides and the coast of Yorkshire, viz., a great arenaceous formation for the most part highly ferruginous. It contains many characteristic British fossils, and uniformly caps the lias throughout Wirtemberg, Bavaria, Hanover and Westphalia, and in some parts (near Banz and in Franconia) it passes up into an iron-shot, true oolite (*oolitischer eisen-stein* of Münster).

The ferruginous grits of this formation, it is stated, are not to be

confounded with the lias grits, from which they are clearly distinguished both by fossils and superposition.

A very detailed section is then given of all the strata exposed in the gorge, called the Porta Westphalica, by which the Weser escapes into the plains of Minden, and where all the sub-formations of the oolitic series, consisting of shales, grits, bands of oolite, &c. are well exposed. The beds are here considerably inclined, and include representatives of the English series, from the top of the lias to shales of the age of the Oxford clay. All this system of the inferior and middle oolite, passes, it is observed, beneath the Bückeberg range of hills, containing sandstone and calcareous shale with workable seams of coal, which group the author agrees with M. Hoffmann in referring to the upper system of the oolitic series, and states that it contains many marine shells; whilst he distinctly shows that it is not the green-sand, of which there are clear sections in the immediate neighbourhood.

*Middle Oolite.*—*Jura Kalk*, &c.—The mineralogical characters of the middle oolite of central and southern Germany are pointed out as being essentially different from those of rocks of the same age in Westphalia and Hanover: so that instead of the shales, grits, &c. just described, they consist in one part of compact, cream-coloured limestone, and in another of dolomite. In Franconia (the great region of bears' caves), in the hills opposite Banz, and in many other places, the dolomite usually caps the limestone, the latter containing the greater number of the fossils. In these groups, and in the inferior oolite, Count Münster has detected nearly all the species of Ammonites figured from this part of the series in the Mineral Conchology, with many other new species; and has also procured at least sixty species of Scyphia from the middle *Jura kalk*, and many other zoophytes now figured in Goldfuss.

*Solenhofen Slate.*—The *Jura* limestone or middle oolite is observed within a certain limited district, between Kehlheim on the S.E. and Pappenheim on the N.W., to pass upwards into a slaty, compact limestone, which is exposed in *plateaux* overlying dolomitic *Jura kalk* on both banks of the river Altmühl, but is of sufficiently fine texture, in only a few quarries near Solenhofen, to be worked as lithographic stone\*. The quarries are then described, and their fossil contents, as collected by the author or observed by him in the collections of Count Münster and others, are enumerated. Seeing the prevalence of Pterodactyli, Insects, Crustaceæ, and Tellinites, and knowing that these fossils, together with certain plants, are also found in the Stonesfield slate of England, and further that these slaty beds at Solenhofen immediately surmount limestones, which by their contents are found to be the equivalents of the middle and inferior oolites of England, on which the Stonesfield slate also rests,—he is led to consider it probable that the Solenhofen and Stonesfield slates are of a similar age; an opinion which he believes has been recently expressed by Dr. Boué.

\* For a specific account of this range, see Von Buch's Letter to Brongniart, 1823.

The whole of this slaty group of Solenhofen, &c. is seen near the mouth of the Altmühl to thin out between masses of dolomite ; the whole being surmounted by green-sand and cretaceous deposits.

The author inclines to the opinion that the higher members of the oolitic groups of England, viz. Coral Rag, Portland Stone, &c., have not yet been defined in any part of central Germany, though they may exist in Hanover ; and he is unable to say whether the limestone of Nattheim, Heidenheim, &c., so abundant in corals, is referrible to the upper part of the great oolite or to the coral-rag.

*Green Sand.*—It is remarked that wherever this formation shows itself in Germany, it is nearly always divisible, as in England, into lower or siliceous sandstone, and upper or cretaceous sandstone ; the former known in certain districts as the *quader sandstein*, the latter as the *pläner kalk*. Numerous sections exhibiting these two formations are given in various parts of southern Hanover and the northern flank of the Hartz, where the lower sandstone is sometimes a highly ferruginous rock, at others a white sandstone, in which character it ranges from the northern flank of the Hartz into Saxony and Bohemia. In Westphalia the green-sand series is said to approach still closer to the mineral type of the English group, and sections are described near Bidofeld, Soest Weil, &c. in which not only an upper and a lower green-sand with many characteristic fossils are described, but also traces of a separating stratum of blue marl or gault.

*Chalk.*—The author states that the chalk is quite as clearly separated from the *pläner kalk* in Hanover, as the chalk of the South Downs is from the malm rock or upper green-sand in Western Sussex. He remarks that on the northern flank of the Hartz, Professor Sedgwick and himself observed it to be quite vertical, whilst the underlying green-sands were by great faults thrown up into unconformable juxtaposition ; and he further refers to a memoir recently read by himself, in which the chalk with flints is stated to occur in southern Bavaria, resting in horizontal strata on the granite of the Bohemian mountains ; and he points out as a necessary inference arising therefrom, that the Hartz and Böhmerwald-Gebirge have been elevated at distinct periods.

*Tertiary Formations.*—Those peculiar transition-tertiary formations described by Professor Sedgwick and the author at Gosau, and in the Austrian Alps, are stated to have been not as yet discovered in central Germany, but only along certain points encompassing it, such as at Maestricht, in the Baltic, the Carpathians, and the Alps. The true tertiary formations, though of considerable extent in different parts of the country, particularly in Hanover, Westphalia, &c., are stated to have been hitherto little attended to by native authors. Without endeavouring to give anything like a general account of the tertiary deposits of Germany, the author rapidly enumerates several localities where there are great exhibitions of sands, clays, lignite, &c. of the age of the plastic and London clays, particularly at Hesse Cassel, and the environs, where the brown coal, &c. of this epoch is traversed, and in parts prismaticized by the overlying basalt (Meisner, &c.). The lower tertiaries are again spoken of as appearing in many points near

Frankfort. In the environs of Mayence, Wisbaden, &c. it is shown that they pass upwards into a great estuary deposit of white limestone and marl, in which fluviatile and land-shells greatly predominate over those of marine origin, and at Monbach are associated with bones of large mammalia; so that the author inclines to the belief of the previous existence of a vast estuary or brackish lake in this spot, the waters of which have been let off by the fissure through the Taunus Mountains in which the Rhine now flows.

The low countries of Westphalia, Osnabruch, Bründe, &c. are specially cited as regions in which a vast development of tertiary marine strata exists; and little doubt is entertained that when fully examined they will afford representatives of most of the formations from the *calcaire grossier* to the crag inclusive, the latter having been already discovered at Antwerp, &c.

The deposits of unmixed lacustrine origin in central and southern Germany, such as Oettingen, Steinheim, &c. are merely named, having been already alluded to in a memoir upon Ceningen, in which the author endeavoured to prove that deposit to be one of the most recent on the surface of the earth; and he terminates this communication with an account of a more newly discovered accumulation of the same nature at Georges Gemünd near Roth, which, from its organic remains, is proved to be of an age intermediate between the gypseous period of the Paris basin, and the youngest lacustrine formations. Beds of sandy marl, and whitish concretionary limestone are said to occur in isolated patches, crowning low hills of *keuper* sandstone at heights of about 150 feet above the present drainage of the district, and containing subordinate layers of calcareous, ferruginous and bony breccia, in portions of which, collected by the author, Mr. Pentland has discovered *Palæotherium magnum*; *Anoplotherium*, a new species, resembling *A. commune*, and a new genus allied to *Anthracotheurium* or *Lophiodon*. Mr. Clift has identified fragments of the teeth and bones of the hippopotamus, ox, bear, &c. Count Münster had previously collected from the same place, remains nearly similar, with the addition of *Palæotherium Orleani*, *Mastodon minutum*, *Rhinoceros pygmaeus* (Münster), *Ursus spelæus*, and a small species of fox. Judging from the appearances on the spot and the evidences there offered of the gradual accumulation of this deposit, the author is of opinion that all these animals were of contemporaneous existence, and that this intermixture of quadrupeds of so old a period as the gypseous limestone of Paris, with others, the genera of which now inhabit our present continents, has supplied a valuable link in the chain of fossil zoological affinities.

The following books are referred to in the memoir: Keferstein, Teutschland, Geognostisch-geologisch Dargestellt; with Maps, &c.—Boué, Synoptische Darstellung.—Boué, Geognostisches Gemälde von Deutschland, 1829.—Merian, Umgebungen von Basel, 1821.—Hoffmann, Nord-westlichen-Deutschland; with Maps, Sections, &c. Berlin, 1830.—Klipstein, Kupferschiefergebirge der Wetterau und des Spessarts, Darmstadt, 1830.—Alberti, Die gebirge des Königreich's Wurtemberg, 1828.—Schwätzenberg, Petrographische carte

von Kreise, Cassel, 1825.—Von Buch, Letter to Brongniart, *Journal de Physique*, Oct. 1822.—Zincken, *Ostliche Hartz*, Brunswick, 1825.—Hausmann, *Uebersicht der jüngeren Flötzgebilde im Flussgebiete der Weser*, Göttingen, 1824.—Oeyenhausen, *Von Dechen und De La Roche*, *Geognostische Umriss der Rheinländer*; with Maps, Sections, &c., Essen, 1825. Together with many memoirs in Leonhard's, Karsten's and other journals.

June 8th.—Henry A. Aglionby, Esq. M.A. of St. John's College, Cambridge, and of the Temple, London; Marmaduke Ramsay, Esq. M.A. Fellow and Tutor of Jesus College, Cambridge; Lord King, of Dover Street; and the Rev. Edward Stanley, Alderley Rectory, Congleton,—were elected Fellows of this Society.

A letter was read, from Joshua Trimmer, Esq. to the Rev. Dr. Buckland, V.P. "On the diluvial deposits of Caernarvonshire, between the Snowdon chain of hills and the Menai strait, and on the discovery of marine shells in diluvial sand and gravel on the summit of Moel Tryfane, near Caernarvon, 1000ft above the level of the sea."

The object of this paper is to point out evidences of extensive diluvial action in that part of Caernarvonshire which lies at and near the N.W. base of the mountains of Snowdonia. This district is traversed in a direction from N.E. to S.W., and nearly parallel to the mountain chain, by two remarkable beds of roofing slate, well known by the name of Penrhyn Slate, dipping usually to the S.E. at a considerable angle, and extending along a series of hills of moderate elevation, between the Snowdonian chain and the Menai strait. Great part of the surface of these hills, and of the still lower ground between them and the Menai, is so covered by accumulations of drifted gravel, sand and clay, that the slate is seldom accessible, without first quarrying down through a thick bed of this diluvium. It occurs, not only in the valleys, but on the sloping sides and summits of hills, sometimes entirely covering the hills, at others accumulated around small projecting crags. It is spread indiscriminately, and with little reference to the rivers that now intersect the country: its greatest observed thickness is about 140ft.

A large proportion of this gravel is composed of pebbles and blocks of various sizes, derived from rocks that occur in Caernarvonshire; many of these are less rolled than pebbles of another class, that are mixed with them, and which have come from a greater distance, and must have been drifted upwards by some violent inundation, in a direction contrary to that of the rivers which descend from Snowdonia into the Menai. Among these pebbles are several which can be identified with the granite, sienite, green-stone, serpentine and jasper of Anglesea: other granite pebbles agree with no rock in Anglesea or Wales, and resemble the granite rocks of Cumberland; some may have come from Ireland or the S.W. extremity of Scotland.

There are also chalk flints, which can have come from no nearer source than the chalk of the county of Antrim.

This diluvium occurs in great thickness in the lower region of the valley of the Ogwen, usually from 60 to 100ft; forming its bed, and often occupying both sides of the valley through which it flows. These

sides, for a considerable distance, afford indications of having received their last form from the bursting of a lake higher up in the valley of the Ogwen.

Shells, and fragments of shells, like those on the shores of the adjacent sea, are reported by the workmen to have been found in the sand and gravel at an elevated spot near Moel Taban, on the right bank of the Ogwen, nearly opposite the quarries of Penrhyn. Mr. Trimmer did not see them here; but on the summit of Moel Tryfane, on the south of Caernarvon, towards Bethgellert, in a sinking made through sand and gravel, in search of slate, at about 20ft below the surface, he found marine shells in a bed of sand; they were for the most part broken, resembling the broken shells on the adjacent beach; when dry, they adhere to the tongue: the fragments are too indistinct to identify species; the genera *Buccinum*, *Venus*, *Natica* and *Turbo* occur among them. Mr. Trimmer found similar broken shells also in the diluvium of the low cliff near Beaumaris.

Beneath the diluvial deposits of this district, when the surface of the slate-rock is newly laid bare, it is found to be covered with scratches, furrows and dressings, like those observed by Sir James Hall on the summit of the Costorphine and other hills near Edinburgh. These furrows and dressings were noticed several years ago by Mr. Underwood: they are referred to the action of the diluvial currents which overspread the country with gravel: some of the larger blocks amid the gravel have also deep scratches upon their surface.

Where the diluvium is argillaceous, the surface of the subjacent slate has been so protected by it, as to remain sound and fit for use as roofing slate up to its line of contact with the incumbent clay; but where the diluvium is of sand or gravel, admitting ready access of water through it to the subjacent slate rock, the slate is often in a shattered state, and bent and decomposed to the depth of many feet below the line of contact.

At the close of this Meeting, which terminated the Session, the Society adjourned till Wednesday the 2nd of November.

PROCEEDINGS  
OF  
THE GEOLOGICAL SOCIETY OF LONDON.

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1831—1832.

No. 23.

Nov. 2.—The Society assembled this evening for the Session.

James Forbes, Esq. F.R.S.E., Edinburgh; and the Hon. Charles Harris, of Privy Gardens, were elected Fellows of this Society.

A paper was read, "On certain younger deposits in Sicily, and on the phenomena accompanying their elevation." By Dr. Turnbull Christie, F.G.S., and communicated by the President.

The observations contained in this essay were made partly during a short visit to Palermo, and partly on an excursion in which the author travelled from Palermo along the northern coast as far as the Castello di Tusa, crossed the central chain of mountains by way of Mistretta and the Monte di Castelli to Nicosia, Leonforte, and Castro-Giovanni, turned eastward by way of San Filippo d'Argire to Catania, and then proceeded along the east coast by Lentini, Syracuse, and Noto to Cape Passero, where he embarked for Malta. In this route he had an opportunity of examining most of the principal stratified formations in Sicily, and hopes to have clearly determined the exact place in the geological series to which many of them must be referred.

The formations described by the author are arranged under the eight following divisions:—

1. The oldest formation which he met with is a sandstone with a few subordinate beds of marl and limestone, occupying a great portion of the central chain of the island, and extending along part of the northern coast. Its exact age he was unable during his rapid tour to determine, but it is older than the Jura or Apennine limestone. In travelling along the coast eastward from Palermo, the author first came on this sandstone near the river Pilato, a few miles to the west of Cefalu; and the island eastward of this point principally consists of the same rock and its accompanying shales. In his route thence to Mistretta he passed over the great chain of the island, which in this part consists entirely of this sandstone, and attains a very great elevation. The mountain of Sancta Diana rises 3875 feet above the level of the sea, and is overtopped by many others within sight, on the loftiest of which, the Madonia, patches of snow were still visible on the 8th of June.

The dip of the sandstone strata is various; but they are in general highly inclined, and sometimes vertical. Their direction is for the most part parallel to the general direction of the chain itself,—namely, inclining from the north of east to the south of west. At Mistretta the strata are seen distinctly to dip away from an anticlinal line,

which passes across the mountain of Sancta Diana, extends between the hill on which the castle stands, and the small hill of S. Catarina on its north, and thence across the valley to the east of Mistretta. At the Monte di Castelli, the highest point near Mistretta, the strata have two different bearings, one nearly east and west, and the other north and south; and a similar observation was made at Nicosia. The author directs attention to the fact, as indicative of the central chain having been raised during at least two distinct periods of elevation.

2. The formation next in order to the sandstone, and of more recent origin, is the limestone and dolomite composing the north-western part of the island, and which the author considers as the equivalent of the Jura or Apennine limestone. It rises in bold, precipitous cliffs flanking the bay of Palermo, and at the distance of about two miles inland bounds the rich plain which lies along the coast. The dolomite closely resembles that of the Tyrol, presenting a bold, rugged outline, without a trace of stratification, and having its naked sides traversed by numerous rents and fissures. Caves, sometimes containing bones, are frequent, formed probably by the enlargement of fissures by the action of water. The limestone, which frequently contains magnesia, is stratified, and the strata are often highly inclined.

3. The third formation distinguished by the author consists of marls and limestones containing Nummulites and Hippurites, and which he believes to belong to the chalk and green-sand formations of other parts of Europe. These beds are horizontal, and lie on trap-tufa and basalt. They were observed at the most southern extremity of Sicily: they extend from the village of Pachino to the sea—occupy the upper part of the island of Cape Passero—and form the base of the small island named the Isola delle Correnti.

4. The next rocks in the series are cretaceous limestones and marls of the older tertiary epoch. In the order of superposition they occupy a place immediately below the tertiary limestone next to be described, which contains shells of existing Mediterranean species, and is hence probably of much more recent origin.

5. The fifth formation is an extensive tertiary limestone, found both north and south of the great central range. Its prevailing character is that of a coarse, yellowish or white limestone, extensively quarried in several places as a building material. Most of its shells belong to species now existing in the Mediterranean, the most abundant being Pectens and Oysters. The genera *Cardium*, *Pectunculus*, *Arca*, with *Echini*, *Serpulæ*, and Corals, are also very common. In the plain of Palermo the strata are perfectly horizontal; but in the valley of the Oretus, where they lie close upon the dolomitic limestone, they are considerably inclined, and are higher by 100 feet than in the plain. A similar disturbance was observed at the Cape delle Mandre. At the south of the central chain the tertiary rocks are still more disturbed, being elevated to several thousand feet above the level of the sea. The direction of these inclined strata is parallel to that of the principal chain.

6. The next formation is a conglomerate still more recent than the



upper tertiary beds last mentioned, and containing shells of species now existing in the Mediterranean. Its character varies in different situations, according to the nature of the rocks of which it is composed. It may be studied as well on the north coast as in the valleys to the south of the central chain, especially in that of the Limetus, between Palermo and Catania, and to the south of Syracuse. Its position, as well as fragments of tertiary rocks contained in it, prove it to be *posterior* to these; its sea shells attest its marine origin; and the perforations by *Lithodomi* prove it to have been covered by the waves prior to its elevation.

7. Of the same age with the preceding conglomerate is the Bone-breccia. Three bone-caves are enumerated by the author as situated in the immediate neighbourhood of Palermo. One of them, the Grotta de San Ciro, about two miles south-east of the town, is situated near the base of the magnesian limestone mountain of Grifoni, close upon the plain of Palermo; while the other two are in the mountain of Bellemi, about four miles to the west of the town, at a considerable elevation, being more than 300 feet above the level of the sea, and 100 feet higher than the cave at San Ciro.

The breccia at San Ciro is not confined to the cave itself, but forms a great part of the external talus, where it rests immediately on the upper tertiary beds, and has a thickness of about 20 feet. The breccia consists of numerous fragments of bones, with some rolled pieces and blocks of limestone cemented together by a little lime or clay; and it has some appearance of stratification, indicative of a deposit from water. The bones have been pronounced by Baron Cuvier to have been those of the Elephant, Hippopotamus, and Deer, with a few of a carnivorous animal of the genus *Canis*.

The author infers from a careful personal examination, that this breccia was deposited by water, and that subsequently to its formation and prior to its elevation, it remained long under the waves. This conclusion he believes to be justified by the appearance exhibited by the sides of the cave, which in some parts are smooth and polished as if long worn by water, and at others are perforated by *Lithodomi*. In this opinion he considers himself fully borne out by a bone-breccia lately discovered near the bay of Syracuse, about 70 feet above the level of the sea, and deposited in caves worn in the tertiary rocks. This breccia is of the same age as that at San Ciro, contains the bones of similar extinct quadrupeds, is intermixed with sea-shells, and has not only been worn by water since its formation, but its substance has been perforated by *Lithodomi*. From all these circumstances, considered in conjunction with the extent of the preceding newest tertiary deposits, the author considers it certain that the extinct quadrupeds, the bones of which are contained in the breccia, must have lived at a period long posterior to that in which the Mediterranean began to be inhabited by its present species of Mollusca, Radiata, and Zoophytes, and before the last convulsion which raised a great part of Sicily above the level of the sea.

The caves at Bellemi were not so minutely examined by the author

as that at San Ciro. In one respect they possess much interest. They are situated at a greater height than the tertiary rocks have attained in that neighbourhood; and neither the caves themselves nor the bone-breccia have any appearance of marine action. The author thence infers that the breccia at Bellemi was above the surface of the sea at the time that the breccia at San Ciro was beneath it; and that their present heights mark the extent to which the tertiary formation at that part has been raised by the great convulsion, by which a large portion of Sicily has been elevated.

8. The last formation noticed by Dr. Christie is diluvium, of which he distinguishes two kinds differing in age. The older diluvium—answering, he conceives, to the *terrain de transport ancien* of Elie de Beaumont—consists of large rolled fragments of sandstone, with a few fragments of the tertiary rocks cemented by a sandy clay, is of the same age as the conglomerate and bone breccia, and occupies considerable heights on the sides and summits of the hills. The newer diluvium is quite distinct from the preceding, occupies only the bottom of the valleys, sometimes to great depth, and consists partly of rolled fragments of older rocks, even of the conglomerate, together with a great quantity of grey clay. They may both be distinctly seen in the valley of the Limetus.

In addition to the general conclusions already mentioned in the history of the bone-breccia, the author considers his observations as affording complete confirmation of the views of Elie de Beaumont regarding the epochs of elevation of the Sicilian mountains. The principal chain, extending across the island to the north of Castro Novo and Nicosia towards Messina, is not only sensibly parallel to the principal chain of the Alps, whence alone, according to Elie de Beaumont, the date of elevation must be the same; but the author contends that both chains were elevated posterior to the formation of the conglomerate and older diluvium, and therefore that their periods of elevation are identical.

Nov. 16.—Martin Tupper, Esq. of New Burlington-street, and Lord Ernest Bruce, of Grosvenor Square, were elected Fellows of this Society.

A paper was read "On a large species of Plesiosaurus in the Scarborough Museum," by John Dunn, Esq. V.P. Scarborough Philosophical Society, and communicated by Roderick Impey Murchison, Esq. P.G.S.

The animal was discovered by Mr. Marshall, of Whitby, imbedded in a hard rock belonging to the upper lias beds, situate between Scarborough and Whitby, near the place where that gentleman had formerly discovered the remains of a crocodile. The skull and cervical vertebræ are wanting, but the rest of the skeleton is pretty entire and measures from the anterior dorsal to the last coccygeal vertebra nine feet six inches. The entire animal, with the head and neck, is estimated to have been nineteen feet long, and it is considered by the author to be identical with the gigantic species from Havre and Honfleur, described by Baron Cuvier, particularly

from the close resemblance in the forms of the vertebræ. It appears to have been about twice the size of the *Plesiosaurus* found at Lyme, and described by Conybeare in the Transactions of the Geological Society \*. The animal is lying on its left side with the vertebræ and the bones of the shoulders and pelvis nearly *in situ*, but the ribs and the bones of the extremities are somewhat broken and detached. The vertebral column has the gentle sigmoid flexure we observe in the *Ichthyosaurus*, being concave before in the dorsal region, and concave behind in the region of the pelvis. The bodies of the vertebræ lie in close contact with each other, and about fifty-nine may be estimated as forming the part of the column from the anterior dorsal vertebra to the end of the tail, which is nearly the same number as that observed in the corresponding part of the specimen from Lyme. Judging from the appearance of the first dorsal vertebra, which is exposed and a little worn, the author concludes that the bodies of the vertebræ present flat surfaces to each other, as in those described by Cuvier from Honfleur. The annular part of the vertebræ is ankylosed to the body of the bone, as in the species from Honfleur. The tubercular expansions of the transverse processes of the dorsal vertebræ are all directed downwards, and not, as in that described by De la Beche and Conybeare, pointing upwards in the middle of the series. The right coracoid bone is pushed down from the head of the humerus, and the expanded bones of the pelvis are thrown forwards to some distance from the vertebral column. One of the arms is pretty entire, and the author considers the flattened form of the bones as indicative of the aquatic life of the animal. The scapula exhibits a suture dividing it into two parts, and the head of the humerus presents a distinct protuberance, for the attachment probably of the pectoral muscles. One of the sacral extremities is detached and inverted, having the tibia and fibula lying next to the pelvis; the other sacral extremity appears to be concealed by the broad bones of the pubis. The author has given as full an account of all the bones of this interesting animal as the hardness of the imbedding rock, or the safety of the specimen, would allow of their examination.

A letter was then read, addressed to the President and Fellows of this Society, "On the ancient and present state of Vesuvius," by Count de Montlosier, For. Mem. G.S. President of the Academy of Clermont Ferrard, &c. &c.

The author offers this short notice on Mount Vesuvius in testimony of the grateful sense entertained by him of having been elected Foreign Member of the Geological Society; and the present communication is intended to convey his opinions, formed during a visit to Naples in the year 1813, in respect to the age and origin of Mount Vesuvius, and of its neighbour Monte Somma.

Having pointed out the direct analogy between the active volcano of Vesuvius, and the extinct volcanoes of Auvergne, formerly

\* Geol. Trans. 2nd Series, vol. i. p. 381—389. pl. 48.

described by him, Count Montlosier proceeds to show that the Monte Somma is the true Vesuvius of the ancients, the present volcano being of posterior formation; and he arrives at this conclusion by various considerations upon the nature and form of Somma, which he supposes to be the remaining segment of a vast elliptical cavity, the other sides of which have since been destroyed. The chief object of the author, however, is to point out the very different origin of such a large crateriform hollow as that of the ancient Vesuvius or Somma, which he attributes to explosions, and the small crater of the present Vesuvius, which gives vent to currents of lava. The former having destroyed the towns of Pompeii and Stabiae, with showers of puzzolana and ashes, the latter having overflowed Herculaneum. He endeavours to strengthen this theory by reference to a peculiar class of extinct craters in the Eifel, in Central France, and in the Phlegrean fields; the circular hollows of which have since been occupied by small lakes usually of great depth. As none of these have lava-currents issuing from them, and many of them are devoid of marks of igneous alteration, they are considered by the author to be of the same origin as the ancient Vesuvius, i. e. craters formed by sudden explosion.

Strabo, Pliny, and Dionysius of Halicarnassus, are quoted in proof of the ancient Vesuvius having had the outline of only one mountain; and it is stated that an antique painting, recently discovered at Pompeii, represented the same fact.

The notice was accompanied by drawings of the supposed form of the Vesuvius of antiquity, before the great eruption under Titus; of the condition of the mountain after that catastrophe, by which it is presumed that its summit was destroyed and blown away in *detritus* and puzzolana, leaving an *enormous* crater; and lastly, of the *final* state of the mountain, presenting three sides of the ancient area broken down, with a parasitic cone and crater established on its flank.

Nov. 30.—Lord Teynham, of Bruton-street; Alexander Logan, Esq. of Vere-street, Oxford-street; Sir Thomas Winnington, Bart. of Stamford Park, Worcestershire; Thomas Egerton, Esq. of Christ Church Oxford, and Tatton Park, Cheshire; Colonel Wingfield, of Onslow House, near Shrewsbury; George Stewart Nicholson, Esq. of Robert-street, Adelphi; W. Long Wrey, Esq. of Thornhill, near Swansea, were elected Fellows of this Society.

A paper "On the Geology of the Southern Provinces of Spain," by Capt. Edward Cook, R.N. F.G.S., was begun; and a communication containing extracts from the memoirs published by M. de Buch in the *Preussische Staats Zeitung*, "On the new volcanic island in the Mediterranean, and its connection with the extinct volcanic island of Pantellaria, and the hot springs of Sciaccia on the coast of Sicily," by Leonard Horner, Esq. V.P.G.S. and addressed to the President, was read.

About twenty-four miles S.E. from the point where Sicily and Africa lie nearest together, is the small island of Pantellaria, almost half way between the two coasts, but rather nearer Africa. It is

of an oval form, about fourteen miles long from N.W. to S.E., and rather more than seven broad. It is under the Sicilian Government, is very fertile, and contains about 7000 inhabitants.

The island is entirely volcanic, and there are three distinct points of eruption, from which the materials have been supplied. The external border is formed almost wholly of a succession of numerous beds of a peculiar kind of trachytic lava of a light greenish-gray colour, and resembling gneiss in its granular, slaty structure. Within this encircling border there rises, as from the bottom of a vast crater, the principal mountain mass of the island, the summit of which is 2000 feet high, composed of pumice and numerous lava streams which have issued from the flanks. From every part of the sides of the mountain aqueous vapour issues, and copious hot springs are found at its foot, which are accumulated in a warm lake of salt-water 6000 feet in circumference.

About seventy miles north-east of Pantellaria lies Sciacca, on the Sicilian coast, where hot sulphureous springs issue continually from fissured limestone, indicating a seat of volcanic action; although no rocks of igneous origin, are found there. Between this point and Pantellaria there are many shoals in the Mediterranean, and on one of these the new island arose in July last, which had been announced by the shocks of earthquakes at Sciacca on the 28th of June. This volcano was seen in eruption by the Captain of a Sicilian ship, who found the sea around the volcano, and at the distance of eight miles from it, covered with dead and half-killed fish. On the 12th of July, floating cinders were found in such quantity near the coast of Sciacca, thirty-seven miles distant from the spot, that fishermen were obliged to cut a way through them with their oars. They found at the same time newly killed fish on the surface of the water, which they sold in Sciacca. M. Hoffmann and his travelling companions visited the volcanic island on the 24th of July, when it was 60 feet high and 800 in its greatest diameter. Cinders and ashes were then ejected, and a column of white smoke rose to the height of 2000 feet.

Two months afterwards the Prussian geologist and his companions paid a second visit to the island, which he then found about seventy feet high. The sea had broken down the black wall of sand in many places, and had formed a kind of moving reef of sand and mud, which made it impossible to land. Large masses were falling from the hill into the water, and it appeared probable that the storms of the coming winter might utterly destroy the whole island.

Dec. 14.—Major T. H. Shadwell Clarke, K.H. of Trevor Terrace, Knightsbridge; Christopher Rawson, Esq., Hope House, Halifax; Evelyn Philip Shirley, Esq. Magdalen College Oxford, and Easington Park, Warwickshire; and John Dickinson, Esq. of Bedford Row, were elected Fellows of this Society.

A letter was first read "On the Influence of Season over the Depth of Water in Wells," from William Bland, jun., Esq. of Hartlip, near Sittingbourne, and addressed to the Rev. William Buckland, D.D. V.P.G.S. &c.

The writer directs attention to a fact, which he has confirmed by numerous observations, that the depth of water in wells, within the district which he has examined, is almost invariably greater in summer than in winter. His observations were made on his own well at Hartlip, in Kent, during twelve successive years, namely, from 1819 to 1830 inclusive; and the general result is, that the depth of water gradually increases from Christmas to June, attains a maximum at Midsummer, and then gradually decreases until about the shortest day, when its depth is a minimum. From the regularity of the phænomena Mr. Bland was induced to extend the inquiry to other localities; and with the aid of Sir J. M. Tylden, of Milsted, and the Rev. F. Wollaston, of Upton House, near Sandwich, he has supplied a large collection of facts, which are comprised in tables and illustrated by drawings. The observations were made principally in the county of Kent, and coincide with what had been previously ascertained at Hartlip. The strata perforated in digging the wells, consisted of chalk in some situations, of green sand at others, of Weald clay at others, and in some places of iron sand. The depth of the wells in water, their depth below the surface of the ground in which they were dug, and their height above the level of the sea, varying with the general elevation of the country in which the wells occur, were very various; and yet they were all uniform in having the greatest depth of water about Midsummer, and the least about Christmas.

A paper "On the stratiform Basalt associated with the carboniferous formation of the North of England," by William Hutton, Esq. F.G.S. was begun.

PROCEEDINGS  
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1831—1832.

No. 24.

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Jan. 4, 1832.—A paper “On the stratiform basalt associated with the carboniferous formation of the North of England,” by William Hutton, Esq., F.G.S., begun at the meeting of the 14th of Dec. 1831, was concluded.

The author's object in this memoir is to detail the range, connexion, and phenomena of the whin sill, which occurs in the lead measures or carboniferous limestone of the North of England.

He commences his observations by enumerating the points at which the basalt is visible within the escarpment of the limestone between Knaresdale and Lunehead; then traces it along the outcrop of that formation from Murton to the Roman wall, near Haltwhistle; next along the wall itself; and afterwards by Gunnerton Crags, Little Swinburne, Hartington, Newbigging, Shield's Dykes, Rugby, and Greenfield, to the Aln near Denwick. Besides the whin thus traced along the escarpment of the limestone, the author includes in this sill or stratum the basalt which occurs in the series of beds displayed on the coast of Northumberland from the Aln to Bamborough Castle; likewise that which appears in the interior between the last point and Belford and Kyloe; and the basalt of the Fern Islands and Holy Island. During the course of this extensive survey the author made the following observations:—

That the basalt within the escarpment, as on Alston Moor and the neighbouring mining districts, dips regularly with the strata of the metalliferous limestone.

That the whin sill in general constitutes but one bed, though sometimes two, and near Bavington three beds; and is found in contact with every stratum belonging to the limestone formation. He noticed that great irregularity prevails in the thickness of the whin; and states that it varies from one to thirty or forty fathoms, sometimes swelling out into dome-shaped masses, though without producing any disturbance in the strata in contact with it.

The igneous action of the basalt he observed to be principally exhibited on the subjacent strata; but he mentions four instances where the incumbent beds of shale or limestone had assumed the same altered characters as the beds below; and one, Gallows-hill near Hatlington, where the limestone above the whin is much contorted.

Lastly, the author draws the following conclusions:—

That the whin is a stratum included in the limestone series, and was deposited subsequently to the beds on which it rests, but ante-

cedently to those which rest upon it : that it was not injected laterally, as Professor Sedgwick proved to be the case with the whin at High-Teesdale, but was produced by an overflowing of lava during the deposition of the limestone group ; and that the alternations of basalt, limestone, sandstone or shale, where they occur, indicate a succession of overflows at different periods.

A paper was then read entitled "Zoological observations on a new fossil species of *Chelydra* from Æningen," by Thomas Bell, Esq. F.G.S. F.R.S., &c.

In this notice the author gives a description of the osteological structure of a fossil tortoise, which was found in the upper quarries of the lacustrine limestone of Æningen, near the lake of Constance.

He proves that the fossil belongs to the genus *Chelydra*, by showing that it possesses the characters which distinguish this genus from every other form of Testudinata ; but he determines, by a table of comparative measurements, that the Æningen specimen is a species distinct from *Chelydra serpentina* or the snapping tortoise of North America.

He concludes his memoir by describing the habits of the recent animal.

Jan. 18.—Nathaniel Thomas Wetherell, Esq., of Highgate, Middlesex ; Captain T. E. Sampson, 22nd Regiment of the Bengal Native Infantry ; The Hon. and Very Reverend the Dean of Windsor, — were elected ordinary Fellows of this Society ; and M. Erlert Mitschirlich was elected Foreign Member of this Society.

An essay "On the geological structure of the Crimea," by Baron Stanislaus Chaudoir, communicated by Sir Alexander Crichton, K.W.S. F.G.S. F.R.S., was read.

The peninsula of the Crimea is described by the author as being naturally divided into two districts ; — that of the plain, and that of the mountains. The plain commences at the isthmus and terminates near Simpheropol, following the direction of the mountains from south-east to north-west. It is level, and watered by very few streams, which are generally dry during the heats of summer. The surface is so uniform and unbroken that the author did not find a single opportunity of observing any rock below the superficial stratum, which belongs to the most recent formations, and consists of shells, analogous to those now living in the neighbouring seas, cemented by sand, lime, and marl. The mountainous district extends along the sea-shore, varying in breadth from 15 to 70 wersts, the principal ranges being those of Ischaterdagh, and Yaila. The rocks of which they are composed the author considers as belonging to the following formations : —

1. Cretaceous deposit with large strata of flints, but which resembles the chalk neither of England nor of France, being always marly. It is the principal formation near Karasoubazar.

2. A limestone accompanying the above, containing in the neighbourhood of Simpheropol great numbers of univalves, and very large oyster-shells.



3. Another calcareous rock, of a compact close grain, and yellowish smoky colour. It is found near Soudak.

4. The jura or oolitic formation, which the author considers to rest on hard, cellular, magnesian limestone (rauhwacke) and on mountain limestone.

5. Rauhewacke, porous, globular, and of a yellow colour, occurring in perfectly horizontal strata on the road from the German colony of Rosenthal to Koutschouk-Kousin.

6. Cavernous limestone, which, as well as the rauhewacke, is found in parallel strata of very great extent, and forms chains of hills, which are less elevated than those of the magnesian limestone.

7. Variegated sandstone in alternate thin strata of a green, brown, red, and yellow colour : it is well developed at Sably and Alma.

8. Conglomerate limestone, which forms the greater part of the environs of Theodosia.

9. Magnesian limestone, constituting the highest mountains of the Crimea. Near Koutlak it rises above all the other formations, having very elevated and isolated cupolas and rounded summits. The flanks of the mountains are generally steep, and often perpendicular, as is well seen at the Falkenberg near Soudagh, and in the mountain chain of Yaila.

10. Red sandstone conglomerate, the component parts of which vary from very small grains to blocks of six feet in diameter. It lies under the magnesian limestone, and is found in very large masses at Koos. Fragments of quartz, flinty slate, limestone, slate-clay, greenstone, and sandstone are contained in it.

11. Quartzite sandstone found at Nikita. The author suspects that this rock was mistaken by Pallas for the old red sandstone. It is always more or less interstratified with wood-coal.

12. Slate-clay, which begins behind Koutlak, on the road from Kapsiter, and ranges towards Gouak, Koutschouk-Kousin, and Kourousin on the road from Alouschta. Throughout its whole extent, the author found it to contain alum, derived from decomposing pyrites. This slate-clay also contains a considerable bed of wood-coal, and masses of clay-ironstone.

13. Basalt, occurring only in beds of inconsiderable thickness and small extent, as at Sably and Kikineis; also near Kozloff, Sebastopol and Theodosia.

14. Greenstone, which occurs on Mount Aioudagh near Koutschouk-Lambat. The serpentine described by Pallas was merely decomposed greenstone.

15. Wacke, accompanied with basaltic hornblende and crystals of black mica, occurs in the greenstone just mentioned.

16. Amygdaloidal basalt, greenstone, and wacke. These rocks are met with near the convent of St. George, on the sea-shore.

17. Argillaceous or clay-stone porphyry, remarkable for its columnar appearance, occurs above Alma, three wersts above Sably.

Feb. 1.—A paper was read “On the deposits overlying the carboniferous series in the valley of the Eden, and on the north-western

coasts of Cumberland and Lancashire," by the Rev. A. Sedgwick, F.G.S. F.R.S., Woodwardian Professor in the University of Cambridge, &c.

The author states that this paper is a continuation of two former communications, and that the details, now laid before the Society, define the geographical limits of the central Cumbrian Mountains; a general description of which will form his next object.

§ 1. He first traces the geographical distribution of the new red sandstone series, which commencing near Kirkby Stephen is expanded, between the central Cumbrian chain and the carboniferous chain of Cross Fell, to the Solway Firth. He then traces the members of the same series along the north-western coasts of Cumberland and Low-Furness; pointing out their modifications of structure—the analogies they present to other British formations of the same age—and their relations to the older rocks on which they rest.

The author describes some protruding masses of the carboniferous series within the area of the new red sandstone. Of these he enumerates three examples:—1st. A contorted mass of carboniferous limestone in the *plateau* of Broadfield, about five miles south of Carlisle.—2ndly. A mass of yellow magnesian limestone at Chalk Beck to the east of the village of Rosley. From its fossils, structure and position, he concludes that it is an outlying mass of the carboniferous limestone.—3rdly. Some masses of carboniferous limestone, sandstone and shale near Aketon, about three miles north of Wigton: and he states his belief that in no place within the area of the red sandstone, could a search for the small beds of coal which alternate with the limestone be made with a greater probability of success than near this place.

§ 2. He then describes in detail the successive deposits exhibited in a coast section extending from the cliffs north of Whitehaven to St. Bee's Head. They are enumerated in the ascending order as follows:—

(1.) Great carboniferous system of Whitehaven; of which some of the great faults and dislocations are briefly noticed.

(2.) A coarse sandstone of great thickness, generally with a reddish tinge, containing, though rarely, traces of calamites, and sometimes appearing to graduate into the true coal measures. It is, however, shown to be on the whole unconformable to the carboniferous series, and to be the exact equivalent of the "lower red sandstone," described in a former paper (Geol. Trans. vol. iii. part I. p. 64), which separates the magnesian limestone and conglomerates from the Yorkshire and Durham coal-fields. It is further compared with a red sandstone, which in Shropshire separates the true coal measures from the magnesian, porphyritic conglomerates.

(3.) Magnesian conglomerates, sometimes of considerable thickness, and formed in the hollows and irregularities of the "lower red sandstone" (No. 2.). They are identified with the similar conglomerates of the valley of the Eden, and of various parts of Yorkshire and of Shropshire; and they appear to be on the exact parallel of the similar conglomerates of the Mendip Hills, Exeter, and the south-western coal-fields.

(4.) Magnesian limestone—sometimes replaced by, or alternating with, magnesian conglomerate.

(5.) Red marl and gypsum—supposed to represent the “lower red marl and gypsum” of the Yorkshire sections. (Geol. Trans. vol. iii. part I. p. 101.)

(6.) Great, red and variegated sandstone of St. Bee’s Head.

From these facts the author draws the following conclusions:—

1st. That in Cumberland, Durham, Yorkshire, and Shropshire, there is the same succession of deposits overlying the carboniferous order—that in all these regions the “lower red sandstone” (No. 2.) represents the *rothe todte liegende* or lowest division of the red sandstone series—and that in some cases the same group (No. 2.) appears to graduate into the true coal measures.

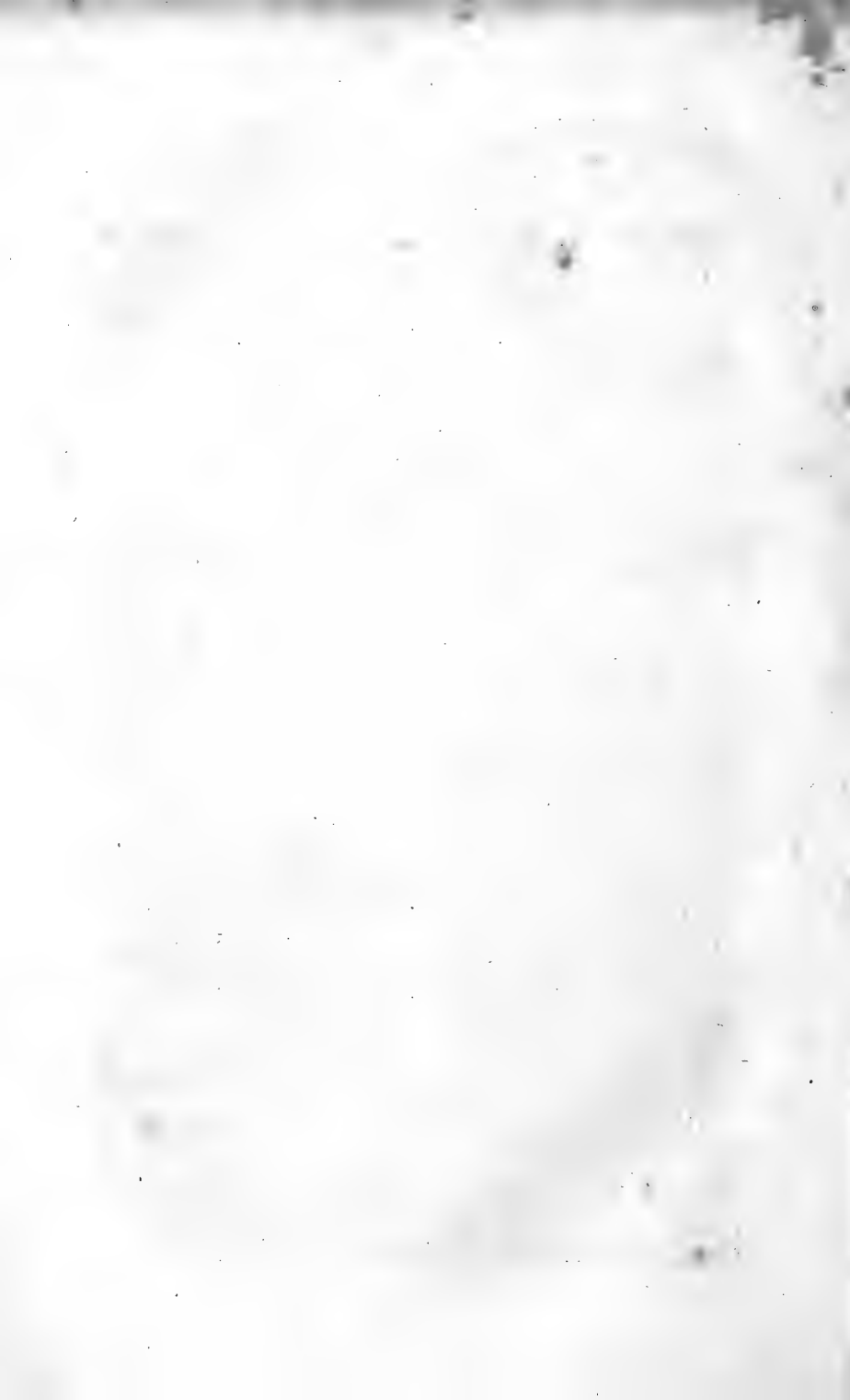
2ndly. That the magnesian conglomerates are an integral part of the formation of magnesian limestone, are superior to the “lower red sandstone,” and sometimes unconformable to it.

3rdly. That the succession of deposits overlying the south-western coal-fields of England is imperfect; inasmuch as the lowest division of the new red sandstone series (No. 2.) is entirely wanting;—a fact easily explained by the discordant position of the overlying groups, and the entire break of any continuity between them and the coal measures.

4thly. That the magnesian and porphyritic conglomerates of the south-western districts of England (being in their mineral structure and in their relations apparently identical with the magnesian conglomerates of the northern counties) do not represent the *rothe todte liegende*, but are on the higher parallel of the magnesian limestone.

§ 3. The author then briefly considers the classification adopted by several continental writers, in which the old red sandstone, the carboniferous series, and the lowest division of the new red sandstone series are regarded as one great complex group; and he endeavours to show, that, however adverse the English succession of the older secondary formations may be to this view, it receives some countenance from the development of the red sandstone and carboniferous series of Scotland.

Lastly, he notices the great masses of red sandstone and conglomerate which fringe the Highland coasts, and doubling along the south flank of the Grampians stretch from one side of Scotland to the other. It is inferred, from their mineral structure and continuity, that they are of one epoch: and as one portion of them is proved by Dr. Fleming to pass under the carboniferous series of Fifeshire, it is inferred (in conformity with an opinion already published by Mr. Murchison and the author) that, considered on the whole, they are nearly on the parallel of the old red sandstone. It is further shown that the Ichthyolites of Caithness and the Orkneys cannot be separated from the same ancient group, and that they are probably on the parallel of other ichthyolites discovered by Dr. Fleming under the carboniferous series of Fifeshire;—a conclusion which does not appear to be invalidated by a single opposing fact.



PROCEEDINGS  
OF  
THE GEOLOGICAL SOCIETY OF LONDON.

---

1832.

No. 25.

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AT THE  
*ANNUAL GENERAL MEETING,*

*17th February 1832,*

The following Report from the Council was read :—

The Council have much satisfaction in making a most favourable Report of the affairs of the Society. The number of Fellows admitted since the last Anniversary, affords at once a proof of the increasing interest which is taken in geological science, and of the continued prosperity of the Society. The numerous donations of Books, Maps, and Specimens have given additional value to the Library and Museum; and the indefatigable zeal of the Curator in classifying and arranging the collection, has supplied facilities for study and reference far greater than the Society had hitherto possessed. The annexed returns will show that the property of the Society is very much increased, and that in every point of view its affairs are in a flourishing state.

REPORT of the Committee on the Museums.

The disposition of the collections in the apartments of the Society has been considerably improved during the last year; the simple Minerals having been removed into the Library; the Scotch and Irish specimens from thence to the lower Museum; the foreign specimens to the upper Museum: so that the lower Museum now includes the whole of the collections from the British Isles.

The Curator has completed the arrangement of the whole of the English and Scotch collections; the specimens of the secondary strata being disposed stratigraphically; and those of the primitive and transition rocks according to the districts in which they have been collected; each respective district being likewise stratigraphically arranged, so far as was practicable.

The Fossils of the several strata are all fixed on boards, and disposed in zoological order.

I. **BRITISH COLLECTIONS.** The following are among the principal Deficiencies which still remain in this part of the series.

The collection from the Crag, and the accumulations above the Chalk, has been improved, but is still defective.

The collection from Portland has been enriched by a present of Cycadeoideæ from Professor Buckland: but that of the other Fossils from this part of the series is very incomplete.

From the Kimmeridge Clay, the Coral-rag, and Oxford Oolite, the collection is very defective.

The collection from the Great and Inferior Oolites has been improved, but is still in many respects defective.

The Fossils of the Lias are defective.

There is a great want of the Fossils of the New Red Sandstone and Magnesian Limestone.

Coal-measures. There is a total want of specimens to illustrate the character of the Millstone Grit and Upper Limestone Shale, throughout the tract from Bristol to Yorkshire.

Mountain Limestone. Collection of Fossils defective.

Old Red Sandstone. A series of specimens of the various pebbles of older rocks, which occur in the conglomerate of this formation, is very much to be desired.

The Specimens from the Transition and Primary Series of England having been arranged, the Committee are enabled to make the following observations.

From Cornwall and Devonshire the series is good.

From the Midland Counties of England, especially those bordering on Wales, and from Wales itself,—with the exception of a very valuable collection from Anglesea, presented by Professor Henslow,—the collection is poor.

As also is that from Westmoreland, Cumberland, and Northumberland, except of the Cheviot Hills.

Of the Scotch collection, the secondary rocks had been partially arranged before the Report of 1830. The Curator has, during the past year, completed the arrangement; and the collection is rich in valuable specimens.

Ireland. A valuable series from the South of Ireland has been presented by Thomas Weaver, Esq. to accompany his Memoir on that district.

There is a small collection of specimens from the Isle of Man, and a few from Guernsey and the other islands in the English Channel.

The President has enriched the collection with one side of the slab containing the Fossil Fox of Æningen, and has presented to the Society the whole of the extensive collections formed by him during his last summer's geological tour through a very considerable part of England. These are principally illustrative of the transition and oolitic series.

**II. FOREIGN COLLECTIONS.** Some further progress has been made in the arrangement of this part of the Museum. The principal additions have been:

1. A collection of Fossil Bones from Wellington Valley in Australia, presented by Major Mitchell, Surveyor General in New South Wales, and accompanied by a Memoir, Map, and Drawings.

2. Specimens of Rocks, collected by Captain P. P. King, R.N. during his survey of part of the shores of South America.

3. A collection of specimens made by Captain Belcher during his survey of the coast of Africa in 1830 and 1831.

The two collections last mentioned have been presented by their donors, with the permission of the Lords of the Admiralty.

The Committee cannot forbear particularly to mention a magnificent specimen of *Mæandrina cerebriformis* from Bermuda, presented by John Taylor, Esq. the Treasurer of the Society.

III. LIBRARY. Donations of Books and Pamphlets, to the amount of 97, have been presented to the Society since the last Anniversary.

A new Alphabetical Catalogue of the Library has been completed and fairly transcribed.

The simple Minerals having been brought down into the Library, it is desirable that the Books on Mineralogy should be removed to the same place.

The Committee recommend that Deshayes's *Coquilles Fossiles des Environs de Paris* should be completed :—

And they suggest, as very desirable, that the Foreign Journals, and Transactions of Societies connected with Geology, be extended and completed : and that such measures as the Council may think proper, be taken to complete the copy of the Ordnance Map of England, of which part is already in possession of the Society.

IV. The Committee cannot conclude this Report without calling the attention of the Council to the fact, that the Curator, in order that his arrangement of the Collections might not interfere with his other duties, has hitherto devoted to the cabinets and to the business of the Society, a very large portion of his leisure hours, and also of his vacation. And they suggest, that it will be highly expedient to guard against such encroachment in future, from a just regard both to the interest of the Institution, and to the health and comfort of Mr. Lonsdale ;—of the great value of whose labours, in the discharge of his various duties, the examination just made by your Committee has afforded new proofs.

W. J. BRODERIP.  
W. D. CONYBEARE.  
W. H. FITTON.

*Geological Society,*  
*Feb. 13, 1832.*

Comparative Statement of the number of the Society, at the close of the years 1830—31.

Fellows.	31st Dec. 1830.	31st Dec. 1831.
Having compounded .....	59.....	64
Contributing .....	177.....	187
Non-residents.....	272.....	288
	<hr/>	<hr/>
	508	539
Honorary .....	50.....	50
Foreign Members .....	56.....	58
Personages of Royal Blood ....	3.....	3
	<hr/>	<hr/>
	617	650

*The following Persons were elected Fellows and Foreign Members during the Year 1831.*

January 19th.—Robert Trotter, Esq. of St. John's College, Cambridge; and Thomas Hodgson Holdsworth, Esq. of Gray's Inn Square.

February 2nd.—Robert Francis Seale, Esq. Secretary to the Governor at St. Helena, &c.; and James C. Somerville, Jun. M.D. of Princes Street.

February 16th.—John MacDonell, Esq. of Upper Gloucester Place, Dorset Square; John Evans, Esq. of Hertford Street, Mayfair; and John Badams, Esq. of Birmingham.

March 2nd.—Robert MacCallan, Esq. of Hampton Wick, Middlesex; the Very Rev. the Dean of Carlisle, of Grosvenor Street; and William Hawes, Esq. of Russell Square.

March 16th.—Charles Barclay, Esq. of Grosvenor Place; and Henry Bickersteth, Esq. of Caius College, Cambridge.

March 30th.—Lord Viscount Norreys, M.P. of Great Stanhope Street, Mayfair; Sir John Johnston, Bart. M.P. of Lower Grosvenor Street; Samuel Duckworth, Esq. of Trinity College, Cambridge; William John Hamilton, Esq. of Stanley Grove, Chelsea; and Charles H. Carnegie, M.D. of Edinburgh.

April 13th.—The Rev. Henry Browne of Corpus Christi College, Cambridge.

May 11th.—William Richardson, Esq. of Christ Church, Cambridge.

May 25th.—Rev. Thomas Worsley, of Downing College, Cambridge; Rev. Robert Willis, of Caius College, Cambridge; and Marquess Ramsay, Esq. of Jesus College, Cambridge.

June 8th.—Henry Aglionby Aglionby, Esq. of St. John's College, Cambridge; Lord King, of Dover Street; and the Rev. Edward Stanley, of Alderley Rectory, Congleton.

November 2nd.—James Forbes, Esq. of Edinburgh; and the Hon. Charles Harris, of Privy Gardens.

November 16th.—Martin Tupper, Esq. of New Burlington Street; and Lord Ernest Bruce, of Grosvenor Square.



November 30th.—Right Hon. Lord Teynham, of Bruton Street ; Alexander Logan, Esq. of Vere Street, Oxford Street ; Sir Thomas Winnington, Bart. of Stanford Park, Worcestershire ; Thomas Egerton, Esq. of Christ Church College, Cambridge ; Colonel Wingfield, of Onslow House, near Shrewsbury ; George Stuart Nicholson, Esq. of Robert Street, Adelphi ; and William Long Wrey, Esq. of Thornhill, near Swansea.

December 14th.—John Ashton Yates, Esq. of Liverpool ; Major T. H. Shadwell Clerke, K.H. of Trevor Terrace, Knightsbridge ; Christopher Rawson, Esq. of Hope House, Halifax ; Evelyn Philip Shirley, Esq. of Magdalen College, Oxford ; and John Dickinson, Esq. of Bedford Row.

*Foreign Members elected in 1831.*

Karl Ernest Adolf von Hoff ; and M. Eilert Mitscherlich.

The Names of the Fellows deceased, within the past year, are as follows :—

Compounders .....	(None.)
Residents.....	(None.)
Non-residents .....	{ Marmaduke Ramsay, Esq. Right Rev. J. M. Turner, D.D. Bishop of Calcutta.
Foreign .....	
Honorary.....	(None.)

The MUSEUM has received many Donations since the last Anniversary, among which are included the following :—

*British and Irish Specimens.*

- An Ammonites from the Calcareous Grit ; presented by T. O. Anstie, Esq. F.G.S.  
 Fossils from the Green-sand near Warminster ; presented by the Rev. B. Richardson, Hon. Mem. G.S.  
 A slab of Dudley Limestone ; presented by Earl Dudley.  
 Fossils from the Chalk, Green-sand, and Weymouth-beds ; presented by Miss Benett.  
 Fossils from the Chalk, Lower Green-sand, Coral-rag, Inferior Oolite, Lias, &c. ; presented by Henry H. Goodhall, Esq. F.G.S.  
 Specimens from the Coral-rag of Yorkshire ; presented by W. D. Saull, Esq. F.G.S.  
 Coprolites, and casts of Coprolites, from the Lias, and Cycadeoidea from Portland ; presented by the Rev. Dr. Buckland, V.P.G.S.  
 Specimens from the South of Ireland ; presented by T. Weaver, Esq. F.G.S.  
 Specimens illustrative of the Mines of Cornwall ; presented by W. S. Henwood, Esq. F.G.S.

- Fossils from the Isle of Sheppey; presented by the Rev. H. Engleheart, F.G.S.
- Minerals from Cornwall, &c.; presented by the Rev. James Yates, F.G.S.
- An Orthoceratite from the Limestone at Newton-on-the-Moor, near Felton; presented by the Rev. James Cook.
- Casts of Impressions in Red Sandstone, presented by Henry Witham, Esq. F.G.S.
- Fossils from Leckhampton Hill, and additional Specimens from the Isle of Wight; presented by S. P. Pratt, Esq. F.G.S.
- Corals from the Mountain Limestone of Flintshire; presented by J. Taylor, Jun. Esq.
- Specimens found in the Clay Iron-stone of the New Hadley Iron Works, near Wilmington, Shropshire; and a specimen of Chondrenite from Cornwall; presented by T. H. Holdsworth, Esq. F.G.S.

*Foreign Specimens.*

- Specimens from the Isthmus of Darien; presented by J. A. Lloyd, Esq.
- Silicate of Copper and Sulphate of Barytes, containing native silver, from Coquimbo in Chili; presented by Alexander Caldcleugh, Esq. F.G.S.
- Recent Shells and Corals from Australia, &c.; presented by Archdeacon Scott, F.G.S.
- Specimens from the Caucasus; presented by Col. Monteith.
- A collection of Bones from the Caves in Wellington Valley, New South Wales; presented by Major Mitchell, F.G.S.
- Four recent Corals from Sincapore; presented by R. I. Murchison, Esq. Pres. G.S.
- Geological Specimens from Pasco in Peru; presented by H. J. Brooke, Esq. F.G.S.
- Fossil Corals from Pappenheim and Nuttheim; presented by the Duke of Buckingham, F.G.S.
- Cast of *Fucoides Alleghaniensis*; presented by G. W. Featherstonhaugh, Esq. F.G.S.
- Specimens from Van Dieman's Land, Ems, &c.; presented by Leonard Horner, Esq. F.G.S.
- A collection of Geological Specimens made by Capt. P. P. King, R.N., during his survey of Terra del Fuego, Cape Horn, &c.; presented by Capt. King, by permission of the Lords of the Admiralty.
- Specimens of Iron Ore from the Cerro del Meriado; presented by the Directors of the United Mexican Mining Association.
- A Block of Gibraltar Breccia; presented by Dr. Buckland, V.P.G.S.
- Geological Specimens from Malta and Sicily; presented by Turnbull Christie, M.D. F.G.S.
- Head of an Hippopotamus, from the river Gambia; presented by Dr. Tebbs.
- A collection of Specimens made by Capt. Belcher, during his survey on the coast of Africa in 1830 and 1831; presented by Capt. Belcher, by permission of the Lords of the Admiralty.

Fossils from Gerolstein, Blankenheim, and Weissebach; presented by F. W. Hoeninghaus, Esq.

Fossils from Normandy; presented by A. Majendie, Esq. F.G.S.

Fossils from the Rock of Gibraltar; presented by Lieutenant Col. Harding.

A Specimen of recent *Mandrina cerebriiformis*; presented by John Taylor, Esq., Treas. G.S.

The LIBRARY has been increased by the donation of ninety-seven works and pamphlets.

The Second Part of the Third Volume of the 'Transactions of the Society will appear in a few days.

The following LIST contains the NAMES of all the Persons and Societies from whom Donations to the Library and Museum have been received during the past year.

Academy of Science at Philadelphia.

Anstie, T. O. Esq. F.G.S.

Babbage, Charles, Esq. F.R.S.

Belcher, Capt. R.N. F.G.S.

Benett, Miss.

Boué, Ami, M.D. For. Mem. G.S.

Brayley, Jun. E. W. Esq.

Brockedon, W. Esq.

Brooke, H. J. Esq. F.G.S.

Buch, Leopold von, For. Mem. G.S.

Buckingham, His Grace the Duke of, F.G.S.

Buckland, Rev. W. DD. V.P.G.S.

Caldcleugh, Alex., Esq. F.G.S.

Cambridge Philosophical Society.

Cheek, Henry, Esq.

Christie, A. Turnbull, M.D. F.G.S.

Clift, W. Esq. F.G.S.

Cole, Viscount, M.P. F.G.S.

Cook, Rev. J.

Daubeny, C. G. B. M.D. F.G.S.

De la Beche, H. T. Esq. F.G.S.

Dudley, Earl of, F.R.S.

Editors of the Horticultural Register.

Editor of the Athenæum.

Egerton, Sir Philip, Bart. F.G.S.

Engleheart, Rev. H. F.G.S.

Faraday, Michael, Esq. F.G.S.

Featherstonhaugh, G. W. Esq. F.G.S.

Forster, Thomas, Esq.

Geological Society of France.

Goodhall, H. H. Esq. F.G.S.

Griffin, John, Esq.

Hall, E. Esq.

Harding, Lieut. Col.

Harlan, Dr.

Hart, J. Esq.

Hausmann, J. F. von.

Henwood, W. S. Esq. F.G.S.

Hœninghaus, F. W.

Holdsworth, T. H. Esq. F.G.S.

Humboldt, A. Baron, For. Mem. G.S.

Hutton, Wm. C. Esq. F.G.S.

Institute of France.

Jones, H. Capt. R.E.

King, Capt. P. P. R.N. F.R.S.

Leeds Philosophical Society.

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| <p>Lloyd, J. A. Esq. F.R.S.<br/>         Loudon, J. C. Esq. F.G.S.</p> <p>Majendie, A. Esq. F.G.S.<br/>         Medico-Botanical Society.<br/>         Meyer, M. Esq.<br/>         Mitchell, Major, F.G.S.<br/>         Monteith, Col.<br/>         Murchison, Roderick Impey, Esq.<br/>         P.G.S.</p> <p>Necker, L. A. For. Mem. G.S.</p> <p>Page, Frederick, Esq. F.G.S.<br/>         Pentland, M.<br/>         Phillipps, Mrs.<br/>         Phillips, R. Esq. F.R.S.<br/>         Pratt, S. P. Esq. F.G.S.</p> <p>Reinwardt, C. G. Esq.<br/>         Rensselaer, Hon. Stephen von.<br/>         Richardson, Rev. B. Hon. Mem.<br/>         G.S.<br/>         Rodd, M. E. Esq.<br/>         Royal Society of London.<br/>         Royal Institution.<br/>         Royal Astronomical Society.</p> | <p>Royal Berlin Academy.<br/>         Royal College of Surgeons.<br/>         Royal Irish Academy.</p> <p>Saull, Devonshire, Esq. F.G.S.<br/>         Scott, Rev. Archdeacon, F.G.S.<br/>         Serres, M. de.<br/>         Silliman, Benjamin, M.D. For.<br/>         Mem. G.S.</p> <p>Taylor, John, Esq., Treas. G.S.<br/>         Taylor, John, Jun. Esq.<br/>         Taylor, Richard, Esq. F.G.S.</p> <p>Underwood, S. Esq. F.G.S.<br/>         United Mexican Mining Ass.</p> <p>Weaver, T. Esq. F.G.S.<br/>         White, C. Esq. F.G.S.<br/>         Witham, H. T. Esq. F.G.S.<br/>         Woodward, S. Esq.</p> <p>Yates, Rev. James, F.G.S.<br/>         Yorkshire Philosophical Society.</p> <p>Zoological Society.</p> |
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*List of PAPERS read since the last Annual Meeting, Feb. 18, 1831.*

- March 2.—On the Rippled Markings of many of the Forest Marble-beds north of Bath, and on Foot-tracks of certain Animals occurring in great abundance on their surfaces; by G. P. Scrope, Esq. F.G.S. F.R.S. &c.
- March 2 and 16.—A Description of Longitudinal and Transverse Sections through a portion of the Carboniferous Chain between Penigent and Kirkby-Stephen; by Professor Sedgwick, F.G.S. F.R.S. &c.
- March 30.—Geological Remarks on the Vicinity of Swan River, and on Isle Buâche or Garden Island, on the coast of Western Australia; by the Rev. Archdeacon Scott, F.G.S.
- April 13.—An Account of the Limestone Caves at Wellington Valley, and of the Situation, near one of them, where Fossil Bones have been found; by Major Mitchell, F.G.S. &c. Surveyor Gen. of New South Wales.
- April 27.—On some Effects of the Atmosphere in Wasting the Surfaces of Buildings and Rocks; by John Phillipps, Esq. F.G.S. &c.

April 27.—An Extract from a Letter of the Rev. George Greg, explanatory of certain subterraneous sounds, occasionally heard at Nakoos, near Tor, in Arabia ; communicated by the President.

May 11 and 25.—Notes on the Secondary Formations of Germany, as compared with those of England ; by R. I. Murchison, Esq. Pres. G.S. F.R.S. &c.

June 8.—A Letter on the Diluvial Deposits of Caernarvonshire, between the Snowdon Chain of Hills and the Menai Straits ; and on the Discovery of Marine Shells in diluvial sand and gravel on the summit of Moel Tryfane, near Caernarvon, 1000 feet above the level of the sea ; from Joshua Trimmer, Esq., and addressed to the Rev. Dr. Buckland.

November 2.—On certain younger Deposits in Sicily, and on the Phenomena accompanying their elevation ; by Alexander T. Christie, M.D. F.G.S.

November 16.—An account of a Plesiosaurus in the Museum of the Philosophical Society at Scarborough ; by John Dunn, Esq. V.P. Scar. Phil. Soc., and communicated by the President.

————— A Notice on Mount Vesuvius ; by the Comte de Montlosier, For. Mem. G.S. President of the Academy of Clermont Ferrand, &c.

November 30.—On the Geology of the Southern Provinces of Spain, by Capt. Edward Cook, R.N. F.G.S.

————— A Letter from Leonard Horner, Esq. V.P.G.S., and addressed to the President, containing extracts from an account published by M. de Buch, of the new Volcanic Island in the Mediterranean, and its connexion with the extinct Volcanic Island of Pantellaria, and the Hot Springs of Sciacca, on the coast of Sicily.

December 14.—A Letter on the Influence of Season over the Depth of Water in Wells ; from William Bland, Esq., and addressed to the Rev. Dr. Buckland, V.P.G.S.

————— 14, and January 4, 1832.—On the Stratiform Basalt associated with the Carboniferous Formation of the North of England ; by William Hutton, Esq. F.G.S.

January 18.—On the Geological Structure of the Crimea ; by Baron Stanislaus Chaudoir, and communicated by Sir Alexander Crichton, K.W.S. F.G.S.

————— Zoological Observations on a new Fossil Species of Chelydra found at Eningen ; by Thomas Bell, Esq. F.G.S.

February 1.—On the Deposits overlying the Carboniferous Series in the Valley of the Eden, and on the North-west Coast of Cumberland and Lancashire ; by the Rev. Adam Sedgwick, F.G.S., Woodwardian Professor at Cambridge.

*Sums actually Received and Expended,*

## RECEIPTS.

Balances in hand Jan. 1, 1831 :	£.	s.	d.	£.	s.	d.
Banker .....	336	13	3			
Accountant.....	40	14	0			
				<u>377</u>	7	3

Arrears :	£.	s.	d.			
Admission Fees .....	75	12	0			
Annual Contributions .....	33	18	0			
				<u>109</u>	10	0

Ordinary Income :	£.	s.	d.			
Annual Contributions .....	434	9	0			
Admission Fees :	£.	s.	d.			
Residents .....	132	6	0			
Non-Residents. ....	73	10	0			
				<u>205</u>	16	0
				<u>640</u>	5	0

Compositions, five .....	157	10	0
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	£.	s.	d.			
Transactions .....	79	1	0			
Proceedings .....	5	18	0			
				<u>84</u>	19	0

Wollaston Fund .....	32	10	4
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£1402 1 7

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during the Year ending December 31, 1831.

PAYMENTS.

Bills outstanding Jan. 1, 1831 :	£. s. d.	£. s. d.
House Expenses.....	13 16 10	
Collector's Poundage.....	9 10 6	
Tea for Meetings.....	5 13 9	
Taxes, Parochial Charges.....	15 0 0	
Repairs of House.....	8 12 8	
Scientific Expenditure.....	4 18 7	
		<u>57 12 4</u>

General Expenditure :	£. s. d.	£. s. d.
Household Furniture.....	13 19 5	
Repairs of House.....	10 7 5	
House Expenses.....	152 15 11	
Taxes, Parochial.....	28 15 0	
—, King's.....	52 11 4	
Insurance.....	6 0 0	
		<u>264 9 1</u>

Salaries and Wages :	£. s. d.	
Curator.....	150 0 0	
Porter.....	90 0 0	
Collector's Poundage.....	16 1 0	
		<u>256 1 0</u>

Scientific Expenditure.....	52 10 8	
Stationery and Miscellaneous		
Printing.....	70 1 4	
		<u>122 12 0</u>

Tea for Meetings.....	48 5 0	
		<u>691 7 1</u>

Cost of Publications :	£. s. d.	
Transactions.....	96 19 0	
Proceedings.....	38 0 6	
		<u>134 19 6</u>

Wollaston Fund.....	21 0 0	
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Balances in hand Jan. 1, 1832 :	£. s. d.	
Banker.....	457 2 8	
Accountant.....	40 0 0	
		<u>497 2 8</u>
		<u>£1402 1 7</u>

# VALUATION of the Society's Property; 31st December 1831.

## PROPERTY.

	£.	s.	d.
Balance in hand (see page 351.)	497	2	8
Arrears due to the Society:			
Admission Fees	132	6	0
Annual Contributions	226	6	0
	<u>358</u>	12	0
Estimated value of unsold Transactions	615	19	6
Due from Treuttel and Würtz, on account of Transactions sold	50	0	0
	<u>£1521</u>	14	2

[N.B. The value of the Collections, Library, and Furniture is not here included: nor is the "Donation Fund" instituted by the late Dr. Wollaston, amounting at present to 1084l. 1s. 1d. in the Reduced 3 per cent. Annuities; the dividends thereof being appropriated to the purposes suggested by the Founder.]

JOHN TAYLOR, TREASURER.

## DEBTS.

	£.	s.	d.	£.	s.	d.
Bills outstanding:						
Taxes	14	5	0			
Gas Company	10	0	0			
Curator's Quarter Salary	50	0	0			
Collector's Poundage	10	0	0			
Scientific Expenditure, &c.	25	0	0			
	<u>109</u>	5	0			
Cash belonging to "Wollaston Fund"	71	17	8			
Arrears not likely to be received	110	0	0			
Balance	1230	11	6			
	<u>£1521</u>	14	2			

We have compared the Books and Vouchers presented to us, with these Statements, and find them correct.

Signed, BASIL HALL.  
JAMES YATES.

Jan. 31, 1832.



# ESTIMATES for the ensuing Year 1832.

INCOME EXPECTED.		EXPENSES ESTIMATED.	
	£. s. d.		£. s. d.
Arrears due to the Society, Dec. 31, 1831. (See page 352.)	358 12 0	Debts outstanding Dec. 31, 1831. (See page 352.)	109 5 0
Ditto on account of Transactions sold by Treuttel and Co.	50 0 0	General Expenditure:	
Ordinary Income for 1832 (estimated): £. s. d.		Repairs of House.....	40 0 0
Contributions of 160 Fellows.....	480 0 0	Taxes .....	95 0 0
Admission Fees:		Insurance .....	6 0 0
Residents (20) .....	126 0 0	House Expenses .....	160 0 0
Non-Residents (20) .....	210 0 0	Household Furniture .....	25 0 0
Compositions (three) .....	94 0 0		326 0 0
		Salaries and Wages:	
		Curator .....	200 0 0
		Clerk .....	90 0 0
		Porter and Servant .....	20 0 0
		Collector's Poundage .....	310 0 0
		Scientific Expenditure .....	50 0 0
		Stationery and Miscellaneous Printing .....	120 0 0
		Tea for Meetings.....	40 0 0
		Cost of Publications:	
		Transactions .....	300 0 0
		Proceedings .....	50 0 0
			350 0 0
		Arrears not likely to be received.....	110 0 0
		Employment of the "Wollaston Donation Fund"	32 10 4
		Balance in favour of the Society.....	153 7 0
			£1601 2 4

The Report having been read, it was Resolved :—

1. That this Report be received ; and that such parts of it as the Council shall think fit, be printed and distributed among the Fellows of the Society.

2. That the thanks of the Society be given to William John Broderip, Esq., and Davis Gilbert, Esq., retiring from the office of Vice Presidents.

3. That the thanks of the Society be given to Henry Thomas De la Beche, Esq., retiring from the office of Secretary.

4. That the thanks of the Society be given to Sir John Herschel, K.C.H., Leonard Horner, Esq., Captain John Pringle, the Rev. J. Honynwood Randolph, Captain James Vetch, and Nicholas Vigors, Esq., retiring from the Council.

The Meeting then proceeded to ballot for the Officers and Council for the ensuing year ; and on the glasses being closed, the scrutineers announced that the following gentlemen had been duly elected :—

## OFFICERS.

### *PRESIDENT.*

Roderick Impey Murchison, Esq. F.R.S. & L.S.

### *VICE-PRESIDENTS.*

Rev. William Buckland, D.D. V.P.R.S. F.L.S. Professor of Geology in the University of Oxford.

Rev. William Daniel Conybeare, M.A. F.R.S. Instit. Reg. Soc. Paris. Corresp.

William Henry Fitton, M.D. F.R.S. & L.S.

Rev. Adam Sedgwick, M.A. F.R.S. Woodwardian Professor in the University of Cambridge.

### *SECRETARIES.*

William John Hamilton, Esq.

Edward Turner, M.D. F.R.S. L. & E. Professor of Chemistry in the University of London.

### *FOREIGN SECRETARY.*

Charles Lyell, Esq. M.A. F.R.S. & L.S. Professor of Geology in King's College, London.

### *TREASURER.*

John Taylor, Esq. F.R.S.

## COUNCIL.

William John Broderip, Esq. B.A. F.R.S. & L.S.	George Bellas Greenough, Esq. F.R.S. L.S. & H.S. M.R.A.S.
William Clift, Esq. F.R.S.	Basil Hall, Esq. Capt. R.N. F.R.S. L. & Ed. M.R.A.S.
Viscount Cole, M.P. F.R.S.	William Somerville, M.D. F.R.S.
Henry Thomas De la Beche, Esq. F.R.S. & L.S.	Charles Stokes, Esq. F.R.S. S.A. & L.S. M.R.A.S.
Sir Philip de Malpas Grey Egerton, Bart. F.R.S.	Henry Warburton, Esq. M.P. F.R.S. L.S. & H.S.
Davies Gilbert, Esq. M.P. M.A. V.P.R.S. Hon. M.R.S. Ed. F.S.A. L.S. & H.S. M.R.I.A.	Rev. William Whewell, M.A. F.R.S.
Robert Edmund Grant, M.D. F.R.S. Ed. Professor of Comparative Anatomy in the University of London.	Rev. James Yates, M.A. F.L.S.

*Address to the Geological Society, delivered on the Evening of the 17th of February 1832, by the President RODERICK IMPEY MURCHISON, Esq. F.R.S. L.S. &c.*

GENTLEMEN,

FROM the Reports which have just been read, it appears that, flourishing as our condition may have been under my distinguished predecessors, this Society is moving onwards in a course of continued and increasing prosperity.

Our list of Fellows has been augmented by thirty-five new names : and our foreign list has been honoured by the accession of Von Hoff and Mitscherlich ; the first of whom has much enlarged our knowledge of the causes in operation upon the surface of the earth ; the latter is known to you by his great discoveries in analytical mineralogy.

We have to regret the loss of only two English members of our body. In our foreign associate, the venerable Sömmering, death has indeed deprived us of a most invaluable coadjutor ; but he has fallen ripe in years and loaded with honours\*.

Our collections and library have received most important additions ; and these, together with the whole of our property, have been incalculably increased in value by the lucid arrangements and unabated zeal of our curator.

The Council have attentively considered the most befitting appropriation of the proceeds of the Wollaston Fund for the present year ; and in their wish to comply with the spirit of the bequest of the illustrious testator, who has charged them “ not to hoard these dividends parsimoniously, but to expend them liberally, and, as nearly as may be, annually,” they have resolved to adjudge them on this occasion to Mr. Lonsdale, to enable him during the ensuing summer to continue his researches in the oolitic formations, and to detect the variations of mineral and zoological character, which mark this series in its range to the North of England. By this award of the Council, I feel satisfied, that the science will derive much real benefit in consequence of the closeness of geological observation, and accurate knowledge of natural history, which are so happily combined in the person of our curator.

The earliest communication during the last session, on secondary deposits, was from the pen of Mr. Poulett Scrope, who, although so well known by many able writings on volcanic subjects, had not previously directed much of his attention to the nature of sedimentary formations ; and his accession, therefore, to the small number of working contributors in this branch of inquiry, is to be hailed with satisfaction. From the rippled and wavy markings upon the surfaces of certain beds of the forest marble in Wiltshire, and from the apparent

\* We may rejoice that some of the most precious monuments of Sömmering's skill in fossil comparative anatomy, have been happily secured to the English student by the exertions of Mr. König, and are now exhibited in the British Museum.

impression of the feet of animals thereon, Mr. Scrope infers, that this deposit, though now in the centre of England, was accumulated upon a line of coast, and must have been formed in shallow water, subject to the flux and reflux of tides. Though we admit, in this case, the littoral nature of the deposit, there are many other strata, the rippled surfaces of which, cannot be received in proof of the same mode of accumulation; since, like appearances occur in rocks, which from their imbedded fossils, as well as from their structure, seem to have been formed in very deep seas.

Your late President, Professor Sedgwick, after an interval allotted to the study of the Eastern Alps, has resumed the arduous task, which he had brought so nearly to completion, of explaining the varied and complicated relations of the oldest secondary and transition rocks of the North of England. His first memoir during the past session, is a description of longitudinal and transverse sections, through a portion of the carboniferous chain between Penignt and Kirkby Stephen. In this communication he shows that the mountain limestone, though consisting of many beds separated by shales and sandstones, may be divided into two groups, of which the "great scar limestone" is the lower, having an average thickness of more than five hundred feet, and containing *Orthocerata*, *Trilobites* and *Ammonites*. The younger group contains five beds of limestone, of which the highest, or twelve-fathom limestone of the miners, is associated with many strata of sandstone and shale, and three or four seams of workable coal. The whole of this calcareous system is overlaid by a complex group connected with the millstone grit, and interlaced with beds of shale and one or two seams of coal. By five transverse sections drawn across the prolongation of the great Craven fault, described by Mr. Phillips, as well as by himself in former memoirs, the author points out the peculiar relative movements of the carboniferous and *grauwacké* chains, anterior to the deposit of the new red sandstone.

From his general conclusions we learn,—that the carbonaceous formations become much more calcareous in their range to the north—that from the nature of the associated organic remains, coal has, in some places, been produced in deep seas, and in other places in shallow estuaries—that changes in the mineral character of the contemporaneously formed strata, are usually accompanied by changes in the species of the fossils, whether animal or vegetable—and, lastly, that the valleys in the carboniferous chain, near the lines of section, are not fissures which have been deepened by erosion, but true valleys of denudation.

The last paper, by Professor Sedgwick, is on the red sandstone of the valley of the Eden, and of the coasts of Cumberland and Lancashire. In a section from Whitehaven to St. Bee's Head, he describes the carboniferous strata as being overlaid by a lower red sandstone, containing a few coal-plants, which, though sometimes conformable to, and appearing to graduate into, the coal measures, is more frequently in an unconformable position to them, and therefore is the true base of the new red sandstone series. This lower sandstone is

succeeded, in an ascending order, first by a magnesian conglomerate, quite identical with that which overlies the south-western coal-fields; then by magnesian limestone; afterwards by red marl with gypsum and bands of carbonate of zinc; and, lastly, by the new red sandstone of St. Bee's Head. The identity of different parts of this succession with the groups overlying the carboniferous system of Yorkshire and Durham, is described in detail; and by further comparisons we learn, that the great member of the red sandstone, described in this and former memoirs by the same author, as the equivalent of the *rothetodte-liegende* and the *Grès de Vosges*, is entirely wanting in the south-west of England, the conglomerates of which (near Exeter and the Mendip Hills) stand in the place of the second member of this series, as existing in countries where the system is fully developed.

The concluding part of this valuable memoir, is occupied with a brief reconsideration of the red sandstone formations of Scotland; and the author confirms the views, published by him and myself, respecting the great antiquity of the vast range of red sandstone and conglomerate surrounding the highland regions of Scotland—by pointing out the continuity and mineral identity of the whole range, the south-eastern limb of which has been shown by Dr. Fleming to pass under the coal-fields of Fifeshire—by stating that it has not a single fossil in common with the magnesian limestone series—by instancing a case where a newer red sandstone is found overlying the old red in a transverse position: Finally, from a consideration of the coast sections of Arran, the nature of the carboniferous series of Scotland, and the apparent passage from the coal measures of the North of England into the lower part of the new red sandstone, he concludes, that the succession of the lower, secondary formations of the northern parts of Great Britain, lends some support to the classification adopted in Germany, by which the carboniferous series is placed subordinate to a vast formation of red sandstone.

Mr. W. Hutton has communicated an elaborate memoir on the Whin Sill of Northumberland, which he conceives to have been one of the oldest basaltic eruptions of that neighbourhood, and to have been poured forth at a period, when a great number of the strata of the metalliferous series were not in existence, these having been subsequently deposited on the unequal surface of the basalt.

Professor Sedgwick, many years ago, arrived at a different conclusion. From repeated and careful examination of the southern branch of this great mass in High Teesdale, he ascertained it to have there a wedge-shaped form—to have acted mechanically and chemically upon the strata above and below—and to be interstratified with different beds of limestone and sandstone;—and thence he inferred, that the igneous matter must have been injected laterally between those beds subsequently to their consolidation. He had previously given a masterly view of the great trap dyke of Bolam, which pointing to High Teesdale as the seat of its origin, traverses the southern coal measures of Durham, and seeming to plunge beneath the magnesian limestone, re-appears and continues its course even through the lias and inferior oolite of the Yorkshire Moorlands.

From my own observation in Teesdale, I am of opinion that Professor Sedgwick has faithfully described the facts; and has irresistibly proved the basalt of that district to have been injected laterally; because the overlying depositary beds are quite as much altered in structure, as those immediately below the basalt.

In this discussion, however, we should recollect, that Mr. Hutton has drawn his inferences chiefly from the Northumbrian district, and Professor Sedgwick solely from High Teesdale; whilst the truth may be, that no one portion of this vast range of country can be selected as a type, whereon a theory explanatory of all the phænomena can be constructed; and, as there are independent proofs of several distinct periods of volcanic action in those northern counties, we may feel warranted in endeavouring to explain the phænomena of the whin sill by reference to volcanic operations of comparatively modern date. In central France, for example, not only do we see that basalt, in the form of dykes, has cut through strata previously consolidated; but we have in the very same district, evidence of a continuous series of igneous operations, exhibited in nearly every possible form, from the outburst of sub-lacustrine volcanic ejections, up to sub-aerial craters, which have vomited forth scorïæ and streams of lava: and hence we may, without a strained hypothesis, be disposed to think, that in the elevated region of Western Northumberland, currents of submarine volcanic matter found issue at intervals, which were continued even beyond the period when the oolitic deposits were accumulated.

Mr. Phillips, so well known to you all as the author of that excellent work 'The Geology of Yorkshire,' the second volume of which I rejoice to say is now in preparation, has given us an interesting prelude to a more detailed memoir upon the various modes by which the atmosphere wastes the surfaces of rocks and buildings; a subject which he intends to follow up with copious details, and which must be of essential use in serving to explain many changes continually operating upon the crust of the globe.

A series of observations, made by Mr. William Bland, on the wells in the strata above and below the chalk, both in the Weald of Kent and on the adjacent hills, acquaints us with the curious fact, that the water is always highest about the summer solstice, and lowest about Christmas; and that throughout the district examined, the same law prevails in the waters derived from all the strata, whether consisting of chalk, sand, or clay.

At the conclusion of our last session a letter from Mr. Trimmer to Dr. Buckland, gave us an account of certain diluvial deposits of Caernarvonshire, between Snowdon and the Menai Straits, and on the discovery of marine shells in diluvial sand and gravel on the summit of Moel Tryfane. It is stated, by this author, that gravel, sand, and clay are heaped up, not only in the valleys, but on the sloping sides and summits of the hills, and that the transported materials consist of pebbles and blocks of Caernarvonshire rocks, mixed up with other detritus, derived from formations foreign to this district, and drifted in a direction contrary to the courses of the rivers which now descend

from Snowdonia. Mr. Trimmer discovered on the summit of Moel Tryfane, one thousand feet above the level of the sea, broken shells of recent species of the genera *Buccinum*, *Venus*, *Natica*, and *Turbo*, beneath twenty feet of sand and gravel. The same shells have also been seen by him, in similar accumulations, in the low cliffs of Beaumaris. It is likewise mentioned that the slate-rock, when laid bare, frequently exhibits on its surface, scratches and furrows like those, which have been described in Scotland.

This striking phenomenon, of the sea having overspread the western parts of this island at a period so comparatively recent, led me in a late journey along the north-west coast, to endeavour to ascertain whether the lower country of Lancashire had partaken of similar operations; and I was induced to suppose this might have been the case from the occurrence, as stated by Mr. Gilbertson, of marine shells of existing species near Preston in Lancashire. I was fortunately able to confirm this discovery; and to observe similar phenomena over a very considerable tract of country, occupying the ancient estuary of the Ribble. Sands, marls, and gravels, occasionally constituting terraces, are spread over this great area, sometimes in finely laminated beds, but for the most part loosely aggregated, and bearing a great resemblance to the arrangement of the same materials, now in the act of formation, on the adjoining shore. Many of the shells found in these beds, far inland and at heights extending to three hundred feet above the sea, are perfectly identical with existing species. These circumstances have induced me to dissent from the theory, which would refer all these deposits to a diluvial current; and I have inferred, that the ancient shore of Lancashire, and the estuary of the Ribble, in which the above materials had accumulated during a long protracted epoch, were elevated and laid dry after the creation of many of the existing species of mollusca.

Of communications descriptive of foreign countries, I have first to notice two papers by Fellows of this Society on different parts of distant colonies in Australia. One of them by Archdeacon Scott, accompanied by instructive specimens, is interesting, as being the first attempt at a geological sketch of the country around the new settlement of Swan River. This tract, we are told, has a granitic nucleus, which towards the coast is overlaid by sandstone and limestone; these being succeeded along the shore by coralline and shelly deposits of very modern date.—The other memoir, from the pen of Major Mitchell\*, Surveyor-General of New South Wales, gives an account of the limestone caves in Wellington Valley, and of the bones of quadrupeds, which occur in clefts or cavities con-

\* The author of this memoir, who acquired such deserved scientific reputation in the peninsular war by his beautiful, military drawings of the Pyrenees, has lately announced to me his completion of the Trigonometrical Survey of an important part of our eastern colonies in Australia; after the accomplishment of which he promises to devote much of his time to the examination of the geological structure of those districts.



tiguous to them. Some of these bones, which were procured on the surface, have experienced little or no change, whilst others inclosed in the breccia, are very much in the state of those found at Gibraltar. The examination the bones have undergone since their arrival in Europe shows that, though belonging chiefly to the Marsupial tribes, abounding in that country, there are also remains resembling those of a cetaceous animal, and of the elephant and rhinoceros. If the presence of the bones of these great mammalia be well established, changes must have occurred in the distribution of animals in New Holland, analogous to those which have taken place in other quarters of the globe.

In the absence of better information, I endeavoured to lay before you, in a synoptical form, the knowledge I had acquired during various journeys, of the nature of the different sedimentary deposits of central and north-eastern Germany. In this sketch, the systems of *totte-liegende*, *zechstein*, *kupfer-schiefer*, &c., were rapidly passed over, as I considered them to have been already correctly identified, by Professor Sedgwick, with the magnesian limestone series of England. The *muschelkalk* was shown to be a great calcareous formation in the middle of the new red sandstone, having the *bunter sandstein* below, and the *keuper* red sandstone and marl above it; and the organic remains of this tripartite group to possess a common family character. Banz-on-the-Maine was instanced, as well meriting to be visited by English geologists, because it offers a true lias shale and limestone, (abounding in all the species of *Ichthyosauri*\* known in Dorsetshire) capped by the sands of the inferior oolite; thus presenting a strong resemblance, both in order of position and zoological character, to these formations in England. The gorge called the *Porta Westphalica*, previously described by Hausmann, was cited, as offering a clear and instructive section of nearly the whole of the oolitic series from the lias upwards; and it was mentioned that here, as in many other places, the inferior oolite has the same arenaceous type which distinguishes it throughout so great a part of its range in the British Isles†.

The Jura limestone and dolomite of Franconia, occupying the place of our middle oolites, was shown to be overlaid by the Solenhofen slate, so well known in lithography, and so rich in organic remains; and its age was proved to be coeval with the upper part of the oolitic series, by sections on the Danube, marking its passage beneath the green sand. Various districts, chiefly in Hanover and Westphalia, were described as consisting of a lower

\* Of the *Ichthyosauri* at Banz, the *I. tenuirostris* is by far the most abundant, whilst the *I. communis*, so common at Lyme, is very rare. There are also two species of *Pterodactyli* at Banz, one of which is the *P. Macronyx* of the English lias; the other is a new species. I believe it is the intention of M. Theodori to publish engravings and descriptions of these fossils.

† Yorkshire, Brora, the Hebrides, &c. See Geol. Trans. 2nd series, vol. ii. pp. 293, 353; also Conybeare, and Phillips's, *Outlines of Geology*, &c.

green sand (*quader sandstein*), an upper green sand (*plüner kalk*), and true chalk; and the memoir terminated with an account of one of the most remarkable of the numerous, tertiary formations of Germany. It is a deposit of lacustrine limestone and bone breccia, covering the tops of the undulating hillocks of *keuper* red sandstone, in the plains south of Roth and Nuremberg, and near the villages of George's and Frederick's Gemund. In the breccia, *Palæotheria* and *Anoplotheria*, identical in species with those of the Paris basin, are associated with the *Mastodon* of Auvergne, the *Rhinoceros incisivus* and *pygmæus*, with remains of the bear, the stag, the horse, the fox, a new genus of Carnivora, and other undescribed animals \*. The associated limestone being finely laminated and charged with delicate and well preserved freshwater and land shells, seems to indicate a long period of accumulation, during which, certain animals hitherto considered to have been peculiar to an ancient tertiary age, appear to have been co-existent with species nearly analogous to the present races.

This sketch was prepared, principally with the view of directing the attention of English geologists to the structure of countries similar to their own; some of which have been described by native authors of great merit, whose works ought to become familiar to us all: for it is indeed of high interest to observe the astonishing progress, which our German fellow-labourers have made within the last few years in the study of fossil zoology. In alluding to the necessity of cultivating a more intimate acquaintance with the works of German authors on geology, I may be allowed to say, that this Society conferred a most appropriate honour, when it added to its list the name of Count Münster of Bayreuth; who, though isolated and unassisted, has by spirited exertions augmented his collection of fossils to the extraordinary number of five thousand species, and who has detected in the limestone of Franconia nearly all the characteristic *Ammonites*, and many other shells of the English oolites. His original communications, explanatory of a vast number of new fossils, of which I will here mention only three species of *Pterodactyli*, can be known only by consulting various German and French periodical publications. The splendid work of Professor Goldfuss, of the University of Bonn, to which Count Münster has also contributed so largely, deserves, on this occasion, a special notice; for though not yet sufficiently known in England, it may safely be pronounced to be the most comprehensive and instructive description of fossil Zoophytes and Radiaria, which has yet issued from the continental press.

Among the periodical works of Germany, the new series of

\* When this memoir was read, I was unacquainted with the prior observations of M. Von Meyer of Frankfort, upon those osseous remains (see Karsten's Archiv. vol. vii. p. 181); and it is with great pleasure I now learn from Count Münster, that the same ingenious naturalist is occupied in preparing a complete monograph of the whole of the contents of this deposit.

the *Jahrbuch für Mineralogie und Geologie* must be mentioned as being of that clear arrangement, and of that great general utility to the geologist, which might have been expected from the association of one like M. Leonhard, so deeply versed in the inorganic processes of nature, with so able a naturalist as M. Bronn. Karsten's Berlin Journal must also be noticed; for every Prussian work connected with our science cannot but excite interest among us, so long as that country shall continue to send forth such geologists as Humboldt, Von Buch, Hoffmann, Dechen, and Oyenhausen; all of whom add lustre to the foreign list of our Society.

The fossil tortoise which I had mentioned in a memoir upon Ceningen, has found its way to this country, owing to the liberality of Mr. Bell, who proves it to be a *Chelydra*, allied to the *C. Serpentina*, or Snapping Tortoise, of North America. The paper of this excellent zootomist is of great interest in completing the proofs, that all the animals of this rich deposit, whether fox, tortoise, or lagomys, as well as the insects, were such as would naturally have been associated together on the shores of a freshwater lake, and might have been tranquilly deposited at its bottom in alternating layers with a variety of fishes and lacustrine shells\*.

Sir Alexander Crichton has favoured us with a communication from the Baron Chaudoir on the Crimea, containing much valuable detail of the mineral structure of that Peninsula. This essay will, I trust, incite some of our enterprising associates to explore that region, for the purpose of affording us a clear insight into the precise geological relations of the strata, which, from the general data in Baron Chaudoir's Memoir, we may infer to be very analogous to those of the Morea and parts of Greece, as described by M. de Boblaye; and of the north-western flanks of the Caucasus, as sketched by M. Kupffer.

Dr. Christie has communicated to us some good observations, made by him last summer, during a rapid journey through Sicily; and they give us a fair promise of what we may expect from this accomplished traveller, when he shall have examined the geological structure of those parts of the Peninsula of Hindostan, to which he is now proceeding by the route of Egypt. He describes the general structure of the sedimentary formations of the island, as consisting of an axis of old, secondary sandstone, the two principal chains of which have discordant directions, overlaid by limestone, frequently dolomitic, yet often stratified, of the age of that of the Jura or the Apennines. Marls and limestone, containing Hippurites and Nummulites, constitute the youngest secondary group, and are referred to the green sand and chalk. The oldest tertiary deposits, made up of limestones and marls, are succeeded by an extensive calcareous formation, which is charged with many species of existing shells, the beds of which are, in some places, elevated to a height of several thousand feet above the level of the sea. Of still more modern date, and chiefly composed of the detritus of the last-mentioned limestone, is a conglomerate, which

\* See Memoir, Geol. Trans. vol. iii. part ii. p. 277.

also contains recent shells, and which has been extensively perforated by Lithodomi. Of similar age with this conglomerate, is a bone breccia observed by the author in three different caves, one of which is a hundred feet, and another three hundred feet above the sea. As the bones belong to extinct species of the elephant, hippopotamus, &c., and as they are intimately mixed up with recent sea shells, he infers, that these races of large quadrupeds, now extinct, prolonged their duration in Sicily, after the Mediterranean became inhabited by its present species of marine animals; and he proves, by the workings of Lithodomi, that some of the breccia, as at St. Ciro, was long washed by the waves. The detritus of the island is divided by this author into two periods, the older of which is marked by large rolled blocks, and is supposed to be of the same age as the bone breccia; while the smaller and younger occupies the bottoms of valleys.

The venerable Count Montlosier,—desirous of proving to us that the fire of his youth, during which he gave to the world so classical and original a sketch of the old volcanoes of Auvergne, still burns within him,—has sent us a lively account of the impressions made upon him by a first visit to Vesuvius in 1813. It then appeared evident to him, that the present mountain is a parasitic cone, established on the flank of Somma, which he considered to have been the true Vesuvius of the ancients; and that its vast crater must have been produced by one great explosion: a mode of formation to which he assigns the existence of the lake-craters of the extinct volcanoes of the Eifel and of Auvergne.

Dr. Daubeny, having for some time paid much attention to thermal springs, has lately published it as his opinion, that they all owe their origin to volcanic agency, whether they issue from the neighbourhood of active and extinct foci of eruption, or upon linear fissures and dislocations of the ancient strata, produced by expansive forces during former periods of elevation. The views of this able expositor of igneous operations, are entitled to our deepest attention: and in regard to the last-mentioned class of them, it is highly gratifying to observe that the numerous facts adduced by him of the source of thermal waters upon lines of elevation, and at points of fracture, are remarkably supported by the observations of M. Stiff\* in the Duchy of Nassau. Dr. Daubeny supposes that the forces which give rise to volcanoes, are at work throughout the globe; and that the evolution of gases and increased temperature of springs may be looked upon in the light of volcanic phenomena, with the same propriety as eruptions of lava and shocks of earthquakes; and having repeatedly detected the presence of nitrogen gas in thermal waters, he concludes, that the chemical theory of the origin of volcanoes is still to be maintained, as being more philosophical and more consistent with facts and experiments, than the hypothesis of a central ignited fluid, which has been, from time to time, mechanically forced up to the surface of the earth.

\* Ferussac, *Bulletin des Sciences Naturelles*, Juillet 1831, p. 7—12.

Whilst on volcanic ground, I must remark, that the records of the past year have been impressively marked by the appearance and disappearance of an island in the Mediterranean, which, notwithstanding its ephemeral existence, fortunately engaged so large a share of scientific attention, as to have afforded some important data for the explanation of geological phenomena. In these inquiries our countrymen at Malta, appear to have been most active. Sir William Hotham, the Admiral commanding on that station, directed unremitting observations to be made, from the first appearance of this islet above the sea, when visited by Captain Swinburne, to its completion and passage into a quiescent state, when examined and accurately surveyed by Captain Wodehouse: and, fortunately for science, the latter officer was accompanied by a distinguished chemist, who has been the first to furnish his countrymen with a good account of the volcano. Although this able memoir of Dr. Davy has been read before the Royal Society, and will shortly be given to the public, I may here be permitted to state, that a careful examination of all the products of this eruption, both solid and gaseous, has convinced the author that of all the hypotheses of volcanic action, that which was last adopted by his great and lamented brother, and which refers such paroxysmal elevations to the expansive power of steam and gas, generated within the earth by the percolation of water upon an ignited nucleus, is the most easily reconcilable with the phenomena observed upon this spot. We also learn from Dr. Davy that, besides the scoria and cinders of which this island was chiefly constituted, various fragments of dolomitic limestone and sandstone, similar to those forming the nucleus of the adjacent island of Sicily, were brought up in the ejections; and it is further important for geologists to know, that from the accurate surveys of submarine levels in these seas, previously made by Captain Smyth, R.N., as well as from more recent soundings, this island was elevated from beneath a deep sea, and not upon the site of a pre-existing reef of rocks, as had been asserted. Whilst our countrymen were visiting this island, the fortunate proximity of M. Hoffmann on the adjoining coast of Sicily, enabled this meritorious Prussian geologist to visit it on two occasions; and an abridged account of his observations has been transmitted to us by our Vice-President Mr. Horner, and read before the Society. At a later period the French Government sent out M. Constant Prevost, an observer well known for the accuracy of his researches and the ingenuity of his speculations; and we are therefore entitled to hope, that his detailed accounts will throw much additional light on the relations of this new-born island, to many volcanic phenomena of more ancient date. The examination of M. Hoffmann has, indeed, already proved of singular interest, in showing that this eruption occurred on a line which has been subject to volcanic action from remote antiquity, ranging from the extinct volcanic island of Pantellaria by the sulphureous springs of Sciacca to Mount Etna. This author further presents us with the first published explanation of the mineral structure of Pantellaria; although it must be here mentioned, that

this island was, some years ago, visited by one of our fellows, the Duke of Buckingham\*, who brought home with him a rich collection of its minerals.

A year has elapsed since Dr. Buckland, owing to his incessant labour in the completion of other geological works, has favoured this Society with any written communications. Still, I have to record from his pen a lively and instructive account of the geological phenomena, observed by Captain Beechy in his late Polar voyage. The existence of the remains of great fossilized mammalia in Escholtz Bay, had been noticed by the Russian navigator, Kotzebue, who had described them as being commingled in this spot with the bones of quadrupeds now inhabiting those regions. Our skilful Vice-President, having specifically described these fossil bones, infers that the animals to which they belonged, lived at an æra antecedent to the creation of existing species, with which they have recently been mixed up in this locality, simply by the falling away of the ancient cliffs in which they were imbedded. The memoir also contains some excellent remarks on the evidence afforded by these fossils, that the former temperature of this high latitude, on the west coast of America, was similar to that which once prevailed in the northern parts of Europe and Asia.

It is needless, at this period, to expatiate upon the essential value of fossil vegetables in the identification of strata; or to trace the rise and progress of this branch of our science, from those early days when Scheuchzer published an assemblage of plants from rocks of every age under the chaotic title of *Herbarium Diluvianum*, down to the year 1822; when Count Sternberg gave a new impetus to this study by his *Flora der Vorwelt*. The splendid work of the Bohemian nobleman, was followed by attempts of other naturalists to illustrate the fossil plants of their respective districts, among which must be mentioned the English work of Mr. Artis, as explanatory, to a certain extent, of the plants of the Yorkshire coal-field. It is, however, to the more recent efforts of M. Adolphe Brongniart, that we owe the general classification of fossil vegetables, founded on their resemblances to existing genera, as well as on their peculiar characters in certain groups of geological formations. You must have read, with instruction and delight, the *Prodromus* of this author; and there can be no doubt that the continuation of his interesting illustrations, will fulfill the hopes geologists so justly entertain. The bright example of the French botanist soon produced its due effects in this country; and four years have now elapsed since a project was conceived for the publication of a Fossil Flora of the British Isles, by the union of Mr. Lindley (author of the *Introduction to the Natural System of Botany*), with Mr. W. Hutton, an active geologist, peculiarly fitted for such a task, by his habits of accurate ob-

\* M. Donati, a scientific mineralogist, attached to His Grace's suite, has prepared, in the Italian language, an elaborate and correct description of the mineral structure of this island, but unfortunately it has not yet been translated.

servation, and his residence in the Northumbrian coal-field. The appearance of this useful and desirable work, was a long time delayed, owing to the difficulty, I regret to say, of procuring a sufficient number of subscribers. Three fasciculi have, however, now been brought out; and in an ensuing number we shall be presented with an explanation of the general views of the authors. The serious obstacles which oppose themselves to the elucidation of this obscure path in our inquiries, in many cases requiring a perfect acquaintance with existing species of rare exotic and tropical plants, must be appreciated by every one who has laboured in the same field; and working geologists, who are compelled, in the absence of such instruction, to obtain data by slow and imperfect means, are called upon warmly to support those, who, like Messrs. Lindley and Hutton, have thus come forward to lighten their labours. The zeal of Mr. Witham in this department, and his ingenious method of assisting inquiry into the true characters of fossil wood, have been already noticed by my predecessor; and, as other naturalists seem inclined to interest themselves in this pursuit, we may say that fossil botany is at length taking root among us.

In mineral conchology, that most important branch of our fossil evidences, the year has not passed over without its fruits; and those who know the devotion which Miss Benett has bestowed upon this study, and how largely she has thereby contributed to the successful progress of Sowerby's text-book of the science, must have witnessed with sincere pleasure the appearance of the organic remains of Wiltshire, as collected and illustrated by that accomplished lady.

I must now advert to those works of a more comprehensive character, which have been produced in the last year by Fellows of this Society. The English student in geology had so long felt the want of a practical work, which should embrace and systematize all the well authenticated data on which the science is founded, that the warmest thanks of every one of its cultivators are due to Mr. De la Beche, for the ability and perspicuity with which he has compressed them into a portable volume, entitled 'The Manual of the Geologist.' Nothing short of this compendious and instructive digest, in which, without losing sight of general principles, the author has endeavoured to adhere to the impartial rule of *suum cuique*, was to have been expected from the pen of so experienced and acute a geologist; and so eager is the demand of the public for a really good work on this subject, that a second edition has been called for, and is already published.

In noticing the appearance of the second volume of the "Principles of Geology," I cannot but feel my inability to do justice to the merits of a work, which, in the powerful language of the late Professor of Mineralogy in the University of Cambridge, has been termed the "Dynamics of Geology."

As a fellow labourer with Mr. Lyell in France and the North of Italy, when the first idea of this arduous task began to germinate in his mind, I hope to be excused from the charge of vanity on my own

part, or of undue bias towards my friend, when I say that I anticipated no less than this productive harvest from his projected labour in hitherto uncultivated ground; because I had seen in him the most scrupulous and minute fidelity of observation, combined with close application in the closet and ceaseless exertion in the field. Imbued with the prevalent doctrine of the English school of geology, which has worked its way to distinction by a steady accumulation of facts, Mr. Lyell first visited the region of extinct volcanos in central France; where, I might almost say, in the nervous language of Professor Sedgwick, "he acquired a new geological sense, and a new faculty of induction."

In our tour along the southern shores of the Mediterranean, and subsequently in the North of Italy, Mr. Lyell's particular attention was directed to the distribution of the tertiary strata into new groups, according to the proportional number of shells, identical with living species found fossil in each formation. We had convinced ourselves, that the highly inclined strata of the valley of the Bormida, consisting chiefly of green sand, and the same beds, which re-appear in the Superga near Turin, constituted a tertiary group of higher antiquity than the more horizontal Sub-Apennine marls which skirt the southern borders of the plains of the Po; and we were informed by that lamented zoologist, Signor Bonelli, that the fossil shells of the Superga differed, as a group, from those of Parma and other parts of the Sub-Apennines. On the other hand, Signor Bonelli had identified a great portion of the shells of the Superga with the characteristic tertiary shells of the Bordeaux basin and the South of France. In confirmation of these views, he exhibited to us the shells collected from France and Italy in the Museum at Turin, pointing out at the same time that, although some recent species occurred in the Superga beds, they were fewer in number than those in the blue marl and yellow sands of the Sub-Apennines.

When I recrossed the Alps, Mr. Lyell directed his course to the south, and first carefully examined the great collection of Sub-Apennine shells of Professor Guidotti of Parma, amounting to more than one thousand species, with a view of obtaining from that comparison the proportion of living analogues. He next proceeded to interrogate nature in Naples and Sicily, where disturbing forces have been continually in action from remote antiquity; hoping to ascertain whether successive and distinct creations of organic remains, might not have been elevated from beneath the sea, by a series of subterranean convulsions, continued from the period of the mixed Sub-Apennine deposits, uninterruptedly to the historic æra. By letters addressed to myself and others from Naples, it was clear that Mr. Lyell was beginning to unfold the true papyri of geological history; and his subsequent discoveries in Sicily proved, that there were many places in which the extinct species had nearly disappeared, and that amid vast accumulations of marine shells, entering into the composition of mountains of no inconsiderable altitude, nearly all were specifically identical with those now inhabiting the adjoining sea. At this period, therefore, he had, by a



series of inductions, completely effaced from his mind as arbitrary and untrue, those lines of demarcation between, what had been termed, the ancient and existing orders of nature,—fixed by those who had observed the results of her subterranean workings only in countries, where her internal energies have long been dormant.

On the return of Mr. Lyell to Paris in February 1829, M. Desnoyers had just published the first part of his invaluable memoir “On the Tertiary Formations, more recent than the Paris Basin.” From that gentleman he learnt, that M. Deshayes, from a mere inspection of the fossil shells of his rich collection, had already conceived the idea of classing the tertiary formations chronologically, according to the relative number of species in each group, which could be identified with those now living\*. Henceforward, Mr. Lyell became anxious to obtain the co-operation of M. Deshayes in his intended classification of the tertiary strata, and therefore submitted to him the shells which he had procured from Sicily, Italy, the South of France, and the English Crag. M. Deshayes at the same time undertook to hasten the completion of a series of tables of tertiary fossils, intended to form part of a “Manual of Fossil Conchology,” in order that they might accompany Mr. Lyell’s forthcoming volume. I am happy to announce to the Society that these tables have been for some time printed, and that we may expect them to be soon communicated to the English public in the third volume of the “Principles of Geology.”

After the study of these modern deposits, Mr. Lyell was prompted to examine, with increased attention, the effects of the various causes now in operation on the surface of the globe, and it is the execution of this task which has delayed the publication of his views relating to Italy and Sicily.

In the former volume we were made acquainted with his ideas upon the operations of the inorganic forces of nature; and in the present he offers to us his interpretation of an abundant collection of facts, connected with the fluctuations in the organic world. So ample are the data in natural history, upon which the author has established his conclusions, that they cannot fail of relieving him from the charge of visionary speculation. They must indeed demonstrate—that he has anxiously sought for the truth of the laws of Nature in her own works—that he has not only led the way in pointing out a method of inquiry hitherto almost untried, but has, with great skill and patient research, brought the detached accounts of naturalists in every branch of their respective sciences, to bear upon and to illustrate his geological views. Adequate justice cannot be done to a work of this grasp by any observations on unconnected passages; but I cannot avoid noticing the clear and impartial manner in which the untenable parts of the dogmas, concerning the alteration and transmutation of species and genera, are refuted; and how satisfactorily the author confirms the great truth of the recent appearance of man upon our planet.

\* See M. Desnoyers, *Sur un ensemble &c.* Ann. des Sci. Nat. tom. xvi. pp. 216. 441. (1829), in which he announces the views of M. Deshayes and of Mr. Lyell.

The late elevations and depressions of land in the delta of the Indus are well introduced, as correlative of similar phenomena in the Mediterranean and in South America, so much insisted upon in the first volume : and, whatever discrepancies of opinion may still exist among geologists, in reference to various questions—such as, the true origin of elevation-craters—the mode of action by which sedimentary deposits have been altered and crystallized,—the cause of metallic veins—and other obscure problems still remaining to be solved ; all inquirers agree in this fundamental opinion, that the earth's surface has been mainly brought into its present condition by numerous changes of relative level between the land and the sea : we must therefore cordially thank Mr. Lyell for his energetic attempt to elucidate the modes of action by which, in the ordinary course of nature, such revolutions may have been effected.

The last of the English works on geology, which I am called upon to notice, proceeds from an eminent writer, who greatly distinguished himself by his scientific contributions to this Society during its earlier years. I allude to a *System of Geology* recently published by Dr. Macculloch. Instructed as we have all been by the writings of this author, particularly by those which elucidate the origin of the crystallized, igneous, and altered rocks, we have ever been ready to acknowledge the full sense of our obligations to him.

Not content, however, with that share of fame to which his exertions justly entitle him, Dr. Macculloch has now put forth a system, written, as he states, in 1821 ; adding, “ that he has waited ten years in the hope that some better man would stand forward to represent geological science as it is ; but he grieves to say, that during that long period geology has scarcely received a valuable addition, and not a single fundamental one.”

This is an aspersion so groundless, that I should be unworthy of the Chair with which your kindness has honoured me, were I not to repel it. Gentlemen, if you wish to study geological science “ as it is,” in the writings of your own countrymen, you will naturally consult the works of Lyell and of De la Beche. But for a knowledge of what “ it was,” I may request you to peruse these volumes of Dr. Macculloch : for in truth they are chiefly made up of views previously expressed by himself, with the exception of certain passages, I will not now fatigue you with quoting, the sense and bearing of which are, however, at direct variance with the author's published opinions in 1821, although they are transcripts of the opinions of other observers recorded in your *Transactions* within the last five years. This work, in short, is so far from being a new system, that it can hardly be said to enter into the boundless field now opened to modern geologists—the evidence derived from organic remains, the very key-stone of our fabric, being either slightly touched upon, or its value derided. It is, however, a matter of notoriety among working geologists, that even within the limited field of this author's personal observation, a specific acquaintance with such remains has alone been the means, and this within the last five years, of fixing the ages of the secondary deposits in the Hebrides and

around the shores of the Highlands of Scotland. Had Dr. Macculloch read the Geological Transactions, published within the anathematized period, he must have been made conscious of the truth of this statement.

It is indeed by the help of zoological distinctions that modern geology has been carried onwards far beyond the original scope of certain earlier observers, who now seem to feel regret that they can no longer confine it within those mineralogical barriers with which they had endeavoured to surround it. I shall not, however, longer occupy your time with detailed criticisms of the parts of this system; though I must be permitted to advert to two sentences. The first of these is a pointed sarcasm, describing as a person "preferring ancient ignorance to modern truth," that accomplished philosopher, the author of the *Geology of England and Wales*, whose election as a Corresponding Member of the Institute of France has been hailed with gratitude by every English geologist. Yet it is to this very work of the author so stigmatized, that Dr. Macculloch himself actually refers his readers for zoological information\*,—a reference the more remarkable, inasmuch as the authority so cited was produced within that time which Dr. Macculloch characterizes as the period of darkness.—The other sentence is to be found in the title-page, which declares, that this system is followed by an "Explanation of the connexion of a theory of the earth with the sacred records." In the face of this assertion, the work itself goes distinctly to prove the entire *disconnexion* of our science with the inspired writings,—a point, however, on which the author can claim no originality; as the same doctrine was several years ago dwelt upon most energetically by the Rev. Dr. Fleming, who has been followed by other writers, and by no one more eloquently or more conscientiously, than by our President on the occasion of the last Anniversary.

Finally, if there be any geological student who should have been led away by the assertions contained in the preface to this "System," let him reflect, that our present line of research has received the approving stamp of a Wollaston; and that still more recently, we have been urged onwards by the cheering encomium of a Herschel, who in his *Discourse on Natural Philosophy* has told us "that in the magnitude and sublimity of the objects of which it treats, geology ranks next to astronomy, and that at length it is brought effectually within the list of the inductive sciences."

I would now call your attention to the establishment of numerous Provincial Scientific Institutions, for further proofs of that general and increasing taste for natural knowledge, which is spreading so fast throughout this kingdom †. I will not attempt to mention

\* Vol. ii. p. 243.

† Since this address was written I have been delighted to learn, that a Geological Society has arisen at Dublin; and the science cannot but derive most important benefits from the efforts of some of those enlightened men whose names are already enrolled in it.

the proceedings of all these bodies, but will confine my remarks to such of them as have more particularly originated in the efforts of geologists, miners, and fossil collectors.

The Royal Geological Society of Cornwall is to be revered as the precursor of all these provincial institutions; and the value of its Transactions must have been fully appreciated by many whom I now address.

The Philosophical Society of York may be said to owe its origin to the ardent and enlightened views of its first President, the Rev. W. Vernon Harcourt, who succeeded so far in rousing the public spirit of that opulent county, that an elegant building has arisen, which is now stored with specimens of natural history and geology, rendered highly instructive by the skill and good arrangement of the Secretary, Mr. Phillips.—A perusal of the annual discourses of Mr. Vernon Harcourt, will enable you to judge of the many advantages which have flowed from this Institution. To the same individual, philosophy has now to record a deeper obligation, for his unremitting exertions in modelling and giving permanency of character to that national Institution “The British Association for the Advancement of Science,” the first meeting of which was held at the Museum at York in September last\*.

The Institutions of York and Whitby have been imitated by the establishment of others at Leeds, Hull, Halifax, &c.; and at Scarborough, where the oolitic series is so admirably and clearly exposed upon the coast, the scientific traveller will now find a new and appropriate building, filled with all the local fossils, stratigraphically arranged upon a plan of Mr. W. Smith, by an intelligent curator, Mr. Williamson. The Scarborough coast merits to be specially visited by those geologists, who have had the advantage of studying the oolitic series only on our southern shores, where it puts on a type of so very different a mineralogical character. All zoological analogies can now, however, be promptly and clearly established by a comparison of the contents of the museums of Scarborough and Whitby with that of Bath, which owes its value to the arrangement and zeal of Mr. Lonsdale; and with that of Bristol, which has been rendered truly important by the penetrating skill and incomparable collections of Mr. Miller, whose loss we all so much deplore.

The limits of this address prevent my enlarging upon the fossil wealth of many of these Institutions; and I have, therefore, confined myself to the mention of those with which I am personally

\* It is to another Fellow of the Geological Society, Dr. (now Sir David) Brewster, we are indebted for the first suggestion of this admirable mode of concentrating the scientific power of the United Kingdom. (See Mr. Harcourt's discourse in the first report of the British Association.)—Geologists will recur with pleasure to the Meeting at York, because in bringing the working men of science into communication with individuals of rank and property, it was the means, through the exertions of that accomplished nobleman, Lord Morpeth, of inducing His Majesty's Government to grant a well-merited pension to our distinguished fellow-labourer, Mr. W. Smith.

acquainted. This scientific emulation is indeed now spread from one end of Great Britain to the other; Inverness, the chief town of the Highlands of Scotland, having been for some years the seat of the "Northern Institution of Science," which includes in the number of its contributing members the names of Sir George Mackenzie and Sir Thomas Lauder Dick\*.

"The Natural History Society of Northumberland, Durham, and Newcastle-on-Tyne," though of so modern a date, has, within the brief space of one year, promulgated a mass of useful and practical mineral knowledge, in a quarto volume of Transactions. This work contains eighteen communications connected with geological inquiry: the greater number of these are explanatory of the structure of Northumberland and Durham, districts which, however great their national importance, have been till now very imperfectly known in their geological details. The accumulated data of the working men of science in the northern coal-fields were so numerous, that they called for some special organ of communication with the public; and having found one, we are now presented with a surprising mass of underground knowledge, illustrated by sectional drawings and admeasurements of great accuracy and beauty. I can here do little more than enumerate the valuable memoirs comprised in this volume. Several are from the pen of that eminent colliery viewer, Mr. Buddle; among which, the synopsis and sections of the Newcastle coal-field, are invaluable mining and statistical documents. His sketch of the undulatory course of a basaltic dyke may serve to explain many previous difficulties, occasioned by the anomalous appearances of this class of rocks; and his account of the explosion in Jarrow Colliery is of paramount interest to the miner and the philanthropist. Two sections, with full explanatory details by Mr. Nicholas Wood, exhibit the succession of strata along the eastern coast of Northumberland, from the Tyne to the Tweed; and from the sea at Tynemouth to the new red sandstone plain of Carlisle. Messrs. Witham and Winch, in two separate papers, have completely proved the red sandstone of the Tweed to be a subordinate and inferior member of the carboniferous limestone, and not the new red sandstone, to which, from mineral characters, it had formerly been assigned. Mr. Hut-ton has made an important addition to the former discoveries of Professor Sedgwick, and has traced a great and continuous extension of the white and red sandstone, or *totdliegende*, beneath the magnesian limestone, and overlying the coal strata. The volume contains two memoirs by Messrs. Nicholas Wood and Witham, illustrative of fossil vegetables. Mr. W. C. Trevelyan and Messrs. F. and M. Forster have contributed interesting notices of trap-dykes, and of their effects when in contact with limestone, sandstone, and coal: Mr. Williamson Peile, a description of a group of dykes in

\* The Northern Institution of Science, &c., owes no small share of its success to the zeal of its able Secretary Mr. J. Anderson, whose knowledge of the structure of the eastern Highlands has proved so advantageous to every geologist who has visited that country.

the Whitehaven Colliery. The Lothian coal-field in Scotland is sketched by Mr. W. Dunn, who also gives an account of a colliery explosion : and Mr. Francis Forster, a colliery viewer of Northumberland, has communicated a memoir on the South Welsh coal-basin, which contains much practical information, and evinces considerable knowledge in chemistry and mineralogy. I would here, however, remark that this district has for many years been under the examination of Mr. Conybeare, some of whose views of the relations of that most remarkable basin have already been recorded in the Parliamentary Report of 1830 upon the coal trade.

During a late visit to this district, I found with much pleasure, that our Vice-President had already nearly perfected an extensive geological map, and had ascertained the existence of a most important anticlinal line, which had been overlooked by Martin and older observers, and of which Mr. Forster, whose personal examination has been confined to the region west of Swansea, seems to have been ignorant. I hope that another Anniversary will not pass away before the appearance of the long expected memoir of Mr. Conybeare.

Notwithstanding the magnitude of the project, the Natural History Society of Newcastle-upon-Tyne, supported by the proprietors of the adjoining counties, has resolved to undertake the completion of a geological and mineral map of Northumberland, Cumberland, and Durham, with a part of Westmoreland, on which are to be designated all the mines worked out, and the probable range of coal and other minerals yet unexplored.

A similar praiseworthy spirit had previously actuated the proprietors of the county of Mayo in Ireland, who, by a happy choice, employed Mr. Bald to prepare an original map of their county, on the scale of two inches to a mile ; and to trace upon accompanying sections the whole of its ascertained mineral structure—a task which has now been accomplished by that most able surveyor in a style of so great beauty and accuracy, that I have no hesitation in pronouncing it to be unique in this department of art. A deep conviction of the value of such surveys, could alone have stimulated individuals to engage in such arduous undertakings : and their accomplishment affords a triumphant answer to those who, in their ignorance, have scoffed at geology as a science of no practical application.

Having touched upon the subject of maps, I am sure that I express the feelings of every geologist, in saying, that we have derived the greatest aid from many of the gentlemen employed in the Ordnance Survey. The necessary and intimate connexion between their vocation and our own, is too apparent to require any comment ; but in proof of it, I may cite one of my predecessors, Dr. Fitton, as having been eminently successful in his exertions for the promotion of geological inquiry, through the means of the Ordnance surveyors. Even whilst I am penning this address, Colonel Colby and Captain Robe, as if to sanction these statements, have deposited in our archives the new sheets of Herefordshire, the border of Wales, and part of Shropshire, correctly and geologically coloured by Messrs. Wright and Maclauchlan, two gentlemen of the Trigonometrical Survey. For

a long time this Society had been regularly supplied with each published sheet of the Ordnance map. Anxious for the restoration of so useful a gift, which had been discontinued, I made application to the Master-General and Board of Ordnance, and rejoice in now announcing to the Society, that they have complied with this request, in a manner the most prompt and liberal.

From the continent we have just received a map of Teneriffe, which completes the labours in that isle of the great and disinterested geologist, Von Buch. I commend it to your admiration for its beautiful execution, and for its singular value as an accurate delineation of an ancient volcano \*.

The works relating to our science, which have issued from the French press during the past year, are numerous and important; at the same time they are of so easy access, that I shall, on this occasion, simply advert to a few of those which appear to be more connected with inquiries, in which English geologists have been recently occupied.

The vast importance of comparative lists of fossil shells, on which I dwelt when speaking of the "Principles of Geology," has been placed in a new and striking light by that profound conchologist M. Deshayes, for a full comprehension of whose tables I refer you to the report of the Academy of Sciences †; and I have no hesitation in declaring, that since the appearance of the fossil osteology of Baron Cuvier, no work has placed in so strong a light the mutual and inseparable connexion which must ever exist between the progress of zoology and the science which we are associated to cultivate. I trust that the example of M. Deshayes will stimulate naturalists of other countries to prosecute the study of organic remains with the same attention to minute details, united with an enlightened and philosophical regard to the general views of geology.

The theory of that eminent geologist, M. Elie de Beaumont, which, at our last Anniversary, was so fully and clearly expounded by my predecessor, although supported by some distinguished names, has since been warmly contested by M. Boué and other able writers; who, in denying to the author the merit of having been the first to point out that different formations and masses of land have been elevated at distant and separate periods, reject that part of his system which asserts the synchronous elevation of distant mountain chains, parallel to each other.

As the latter part of this subject will, I doubt not, still undergo ample discussion, both on the continent and in England, we must wait for the development of numerous facts before we can be warranted in arriving at general conclusions; and I need scarcely

\* To another distinguished Prussian geologist, the Baron A. Humboldt, we are indebted for a new map of the Cordilleras of the Andes. Germany seems to be annually giving birth to many departmental geological maps; whilst the Empire of Russia has, I am informed, produced no less than sixteen such works within a very short period.

† *Ann. des Sciences*, tom. xxiv. p. 176.

urge all our working brethren, to try the adequacy of M. de Beaumont's ingenious theory by an appeal to nature in our own country.

The new work of M. de Humboldt ("*Fragmens Asiaticques*") presents us with some striking phænomena.

This illustrious traveller, not content with having been the first to clear away the mists which obscured our knowledge of the physical structure of the great continent of South America, has, with all the energy of his character, embarked in the attempt to throw light upon the unexplored regions of the continent of Asia; and we have now before us the outline of his own observations and inquiries, together with those of MM. Rose and Ehrenberg, made during a journey to the Tartarian frontiers of China, under the auspices of the Government of Russia.

Of the four great mountain chains which traverse Asia from west to east, one of them, the Thian Chan, is said to be marked by a line of active volcanos, the chief of which is situated at a distance of from three hundred to four hundred leagues from any sea. This phenomenon is in strict accordance with the recent observations of M. Rüppel, in the interior of Africa, and M. de Humboldt infers from it, that the received doctrine of the sea being necessarily a proximate agent in the causation of volcanic outbursts, is erroneous; and he conceives that the greater frequency of active volcanos along maritime tracts, depends on the less thickness and consequently greater weakness of the earth's crust upon such lines of coast, than in those parts where massive continents have been raised; and that when they occur in the centre of continents, as in central Asia, the molten and gaseous matters find vent through deep rents and fissures.—I need scarcely remind you that the same view had previously been entertained by Mr. Poulett Scrope.

M. de Humboldt believes that the four great chains of Asiatic mountains are parallel to each other; and that this circumstance tends powerfully to confirm the theory of M. Elie de Beaumont. As, however, the personal observations of the author have not extended beyond the Altai, we are as yet wholly unprovided with evidence, whereon the synchronism of the elevations of these mountains, so distant from each other, can be established; for should their parallelism be confirmed by subsequent observations, geologists are still compelled to pause in drawing conclusions as to their contemporaneity of elevation, until the precise nature of the sedimentary deposits on the flanks of each chain, and the manner in which these sediments have been affected, shall have been clearly ascertained.

The existence of a vast depression on the earth's surface, extending beyond the Caspian and the Oural, which had been partially noticed by Englehardt and old travellers, and recently, as respects the former, by Colonel Monteith\*, is now fully explained and much extended by the publication of M. de Humboldt †, who

\* In a memoir lately read before the Geographical Society, and about to be published by that body.

† The Academy of St. Petersburg, at the instigation of M. de Hum-



states that he has already ascertained it to extend over at least 18,000 square leagues, reaching to Saratof, Orenburg, and the low regions of the Oxus and Jaxartes. This great basin, the lowest level of which is about three hundred feet below the Mediterranean, is filled with tertiary deposits; and, according to the speculations of M. de Humboldt, is supposed to have been formed by a subsidence, accompanying the elevation of the great table-land of Teheran, whilst the Oural mountains, which traverse the depression from north to south are referred to a more ancient period.

By consulting these volumes you will find valuable information not only respecting the frigid climate of central Asia, as determined by the great mass of land and other geological causes; but you will learn that the metallic veins in the Oural occur only on its eastern flank, and that remains of large extinct mammalia have recently been found on the very summits of the chain.

Another part of Asia has lately been explored. The Russian Government, with its characteristic enterprise, being desirous of acquiring accurate information respecting the structure, natural history and heights of the Caucasus, sent thither in the summer of 1829, under a strong escort commanded by General Emanuel, a party of men of science, the chief of whom, M. Kupffer, has given in his report to the Academy of Sciences of St. Petersburg.

From the geographical and geological chapters of this interesting report, we learn, that the low hills which rise above the steppes of the Black Sea and Sea of Azof, are composed of limestone filled with littoral shells, the collections of which made by M. Pander, on this and on a former occasion, must prove of great geological importance. On ascending from the steppes towards the Caucasus, grits and older limestones with Ammonites occupy an undulating country, diversified by several peaks of trachyte, the principal of which, the Bechtav, or Five Mountains, is stated to be 4,000 feet above the sea. The outer zone of the Caucasus is described as being a rugged and lofty *plateau*, from 8,000 to 9,000 feet above the sea, the strata of which present tabular summits, chiefly composed of calcareous grit and conglomerates nearly horizontal, or rising at only a gentle angle towards the central ridge. This table-land is fissured by deep, transverse rents, in which the rivers flow; and one of the lowest formations is a limestone, which the author compares with the *calcaire à gryphites*. These secondary strata are separated from the central mountains by a band of transition and old slaty rocks, which have been dislocated by the contact of certain green-stones and basalts. The loftiest part of the central chain, culminating in the double peak of Mount Elbruz at the height of 15,400 French feet above the Black Sea, is entirely of igneous origin, being principally

boldt, is now engaged in directing surveys and barometrical "soundings," as they are emphatically styled, by which the precise extent, depths, and true shore of this dry Caspian will be accurately defined.

composed of a dark-coloured, porphyritic trachyte\*. The volcanic rocks of this region are shown to be of considerable antiquity, because the secondary deposits rest upon them in undisturbed positions, the transition formations having alone been dislocated.

Of the memoirs read before the Geological Society of France, you will find a clear account in the annual reports of its Secretary, Dr. Boué;—those of Count Münster and M. Deshayes on Organic Remains, of Dufrénoy upon the Pyrenees, of Botta upon Mount Lebanon, and of De Boblaye upon Greece, are specially entitled to your attention. The last mentioned of these works might be cited as corroborating an opinion entertained by Professor Sedgwick and myself,—that in parts of Eastern Europe, there exists a series of beds intermediate between the chalk and those deposits, to which the name of tertiary has been commonly assigned. M. de Boblaye, after describing the various primary and secondary rocks of which the Morea is composed, points out the existence of coarse conglomerates and clays, posterior to the green-sand and chalk, and elevated to heights varying from 2,400 to 4,500 feet above the sea, and he regards them as occupying the oldest stage of the tertiary series. These deposits, so little known in the West of Europe, seem to occupy the same geological horizon as the formations of Gosau; whilst the other groups of true tertiary deposits, which succeed at lower levels on the flanks of the Eastern Alps, have also their analogues in corresponding younger deposits on the shores of the Morea.

It must indeed be gratifying to all whom I now address, to note the rapid progress of this infant society of the metropolis of France, founded as it has been upon the model of our own; and you will hear with increased satisfaction, that its zealous and indefatigable Secretary, Dr. Boué, to whom so much of its success is due, has announced the early publication of a first volume of their Transactions†.

Having glanced at the strides which geology has made on the continent of Europe, I would say a few words on the increasing taste for the science, which has lately appeared in the United States of America. You have long gathered instruction from the periodical work of Professor Silliman, whom we have to thank for many valuable memoirs, particularly on the mineralogical structure of his country: but within the past year one of our own body, a man possessed of

\* According to M. de Humboldt this rock is undistinguishable from that of Pinchincha, in the Cordillera of the Andes.

† This volume will contain the Memoirs of Von Lill, on Galicia; Botta, on Mount Lebanon; Bertrand Geslin, on Val d'Arno; Pareto, on the Sub-Apennine Hills; Steininger, on the Transition Fossils of the Eifel; and De Grateloup, on the Tertiary Fossils of Dax. The meeting of French Geologists, which took place last summer at Beauvais, has afforded fresh proof of the zeal which actuates our neighbours, and particularly that excellent observer M. Graves of Beauvais.

great energy of mind, has been endeavouring, by lectures given in Philadelphia, to rouse the educated classes of the southern states to a sense of the importance of modern geology. Having succeeded in creating a love for the subject, Mr. Featherstonhaugh has followed up his first labours by the publication of a new monthly work \*, the leading object of which is to propagate the principles of modern geology. A few numbers only of this useful work have yet appeared, and I refer you to their contents for several spirited descriptions of parts of the United States, and their peculiar organic remains; whilst I earnestly hope that this effort of an unassisted Fellow of our Society, who is labouring to implant in that great country of our kinsmen the principles and nomenclature of the science, as adopted in England, will meet with general encouragement.

Lastly, I have the pleasure to inform you that a new Part of our Transactions will shortly be laid upon the table; and I trust this publication, from the quantity of new and important matter which it contains, will support the reputation to which the Transactions of the Geological Society have so justly attained †.

These volumes must ever be valuable as the true records of our scientific progress. But great as may have been the acquirements of their authors, few indeed are the memoirs which have been completed without the aid of other distinguished Fellows of the Society, who, each in the branch of natural knowledge for which he stands pre-eminent, comes to the assistance of his wandering associate, and enables him to clothe his memoir in an appropriate dress. For where is the working geologist who, unassisted, can unravel the delicate and obscure complications of fossil organic structure? Do his fossil shells require to be identified,—has he not the assistance of a Sowerby? and if these types of former states of nature call for a comparison with modern species,—is not a Broderip ever prompt in affording him the results of experienced discernment, and in unfolding the riches of his unrivalled cabinets? If he meet with difficulties in the determination of mammalia,—are not a Mantell and a Clift at hand to explain their relations and define their characters? Or if bewildered in the obscurity of fossil vegetation,—is he not assisted by a Lindley? Have not, in fine, a Turner, a Prout, a Faraday, and a Herschel, been willing instruments in enabling him to explain those laws of

\* The Monthly American Journal of Geology and Natural Science.—Philadelphia.

† This Part contains the following Memoirs:

Lonsdale on the Oolitic District of Bath.

Murchison on the Fossil Fox found near Eningen, and the Deposit in which it was imbedded.

Mantell, Osteological Description of the Fox.

Herschel on the Astronomical Causes which influence Geological Phenomena.

Sedgwick and Murchison on the Eastern Alps.

chemical change, without which the recondite parts of the science might have remained in utter darkness ?

Surely every contributor to our Transactions will acknowledge with gratitude the aid he may have received from several of our most gifted members, who, unambitious of personal fame, have been contented with the delightful consciousness of being, sure, though silent instruments, in urging on the advance of truth ;—and were I to single out one individual specially characterized by this high quality, I should name your first President, Mr. Greenough, who by the devotion of the best years of his life to our science, and by an unbounded liberality in throwing open to every student the vast accumulations of his knowledge in geological geography, has produced results of which no one can form an estimate who is not acquainted with the interior workings of our Society from its earliest beginnings. It is this kindly principle of co-operation, the true latent heat of the Geological Society, so ready to manifest itself on every occasion fitted to call it forth, which, warming and vivifying our endeavours, gives us our consistency and our strength, and enabling us to grapple with our hundred-headed science, constitutes the main-spring of our prosperity.

Permit me, Gentlemen, in concluding this address, to offer you my heartfelt wishes for the continuance of your triumphant career, and to assure you that I consider myself truly ennobled in having been placed, for a time, at the head of a brotherhood united for purposes so great, and knit together by such lofty and enduring sympathies.

PROCEEDINGS  
OF  
THE GEOLOGICAL SOCIETY OF LONDON.

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1832.

No. 26.

February 29.—A paper “On the Secondary Formations in the neighbourhood of Ludlow,” by J. R. Wright, Esq., employed on the Ordnance Trigonometrical Survey, and communicated by Col. Colby, F.G.S., F.R.S., &c., was first read.

The district described in this memoir occupies a surface of about 167 square miles around Ludlow, and consists of clay-slate, transition limestone, with accompanying beds of shale, old red sandstone, carboniferous limestone, the coal measures, and basalt.

The clay-slate is not described in detail, as it did not form part of the author's personal investigations. The transition limestone and shale are stated to occupy about one-third of the district. The limestone occurs principally in the lower part of the formation, not in regular strata, but in nodules intimately united to the shale in which they are imbedded. The upper part of the formation consists chiefly of a dark bluish grey rock, which passes into a soft argillaceous shale, and contains occasionally calcareous concretions. The thickness of the deposit is estimated to be between 800 and 1000 feet; and the dip of the strata is stated to vary from  $8^{\circ}$  to  $22^{\circ}$ . Besides the continuous band which ranges to the westward of Ludlow, the transition limestone constitutes the narrow ridge, rising above the old red sandstone, called Tinker's Hill and Caynham Camp, about two miles to the south-east of that town.

The old red sandstone, the next formation described, is stated to occupy about one half of the district under consideration, and to be composed of soft, micaceous sandstone, conglomerates, and beds of limestone or cornstone. The general dip of the strata is said to be about  $8^{\circ}$  to the south-east, and the thickness of the formation is estimated to be from 400 to 700 feet.

The carboniferous limestone is mentioned as occurring at only two places, Knowl Hill and Oreton, the most southern and northern points of the Titterstone-Clee-Hill range. The thickness of the principal stratum is said to be twelve yards, and the dip of the formation to vary from  $20^{\circ}$  to  $75^{\circ}$ .

The coal measures are shown to be confined to the same range, and to consist of millstone grit, surmounted by several seams of coal, alternating with the usual strata of shale and sandstone. Sectional lists are given of the principal workings, and the great seam is said to be from 3 to 10 feet thick. The coal-field is much disturbed by faults, and the measures have been partially acted upon by the ba-

salt, which rises through them, and forms a thick deposit resting upon their surface. The author concludes by promising to give, in a future memoir, details of this mass of basalt.

A letter from Sir John Herschel, K.C.H. to Roderick Impey Murchison, Esq., P.G.S., "On the Cause of the Subterranean Sounds heard at Nakoos, near Tor in Arabia," was then read.

The remarks of the author relate to a communication by Mr. Greg, which was read before the Society on the 27th of April 1831. He suggests, as the only probable explanation which occurs to him, that the phænomena may be owing to a subterraneous production of steam, by the generation and condensation of which, under certain circumstances, sounds are well known to be produced. They belong to the same class of phænomena as the combustion of a jet of hydrogen gas in glass tubes.

The author makes the general remark, that wherever extensive, subterraneous caverns exist, communicating with each other or with the atmosphere by means of small orifices, considerable difference of temperature may occasion currents of air to pass through those apertures with sufficient velocity for producing sonorous vibrations. The sounds described by Humboldt, as heard at sunrise by those who sleep on certain granitic rocks on the banks of the Orinoco, may be explained on this principle.

The sounds produced at sunrise by the statue of Memnon, and the twang, like the breaking of a string, heard by the French naturalists to proceed from a granite mountain at Carnac, are viewed by the author as referrible to a different cause, viz.: to pyrometric expansions and contractions of the heterogeneous material of which the statue and mountain consisted. Similar sounds, and from the same cause, are emitted, when heat is applied to any connected mass of machinery; and the snapping often heard in the bars of a grate affords a familiar example of this phænomenon.

March 14.—William Ogleby, Esq., York Street, Portman Square; Francis Boott, M.D., Gower Street, Bedford Square; James Bow-erbank, Esq., Sun Street, Bishopsgate Street; Lieut. Col. Sykes, of the Bombay Establishment; Peter Stafford Carey, Esq., M.A., of St. John's College, Oxford, and Middle Temple, London; and John Fisher, Esq., of Highbury Park, Middlesex,—were elected Fellows of this Society.

A paper was read, which described,

1st. The structure of the Cotteswold Hills and country around Cheltenham:

2nd. The occurrence of stems of fossil plants in vertical positions in the sandstone of the inferior oolite of the Cleveland Hills; By Roderick Impey Murchison, Esq., P.G.S. F.R.S., &c.

#### *I. Structure of the Cotteswold Hills and district around Cheltenham.*

The formations constituting the Cotteswold Hills and Vale of Gloucester, in the neighbourhood of Cheltenham, are described in the following descending order.

(1.) Forest Marble, the upper members of which consist of clays,

containing slaty beds, the equivalents of the Stonesfield slate (Sevenhampton Common, &c. &c.). The lowest member of this group is a hard calcareous grit, which caps the hills of Lineover and Leckhampton, and is peculiarly distinguished by the abundance of a *Gryphæa*, a variety of *G. cymbium*? together with *Lima proboscidea*, *Pholadomya ambigua* and *P. fidicula*, *Trigonia striata*, &c. &c.

(2.) Great Oolite—consisting of upper and lower rags, inclosing a fine-grained building-stone, the united thickness of which in the precipitous escarpment of Leckhampton is estimated at upwards of 120 feet. The fossils are nearly the same as those of the great oolite of Bath. The Bradford clay and Fuller's earth are entirely absent, the upper rags of the great oolite being separated from the forest marble by only a small loamy wayboard of a few inches, and the lower rags pass into the inferior oolite.

(3.) The Inferior Oolite is described at its maximum thickness in Crickley Hill, occupying about 60 feet, whence it thins off in its range to the north-east, presenting about half that thickness beneath Cleeve Clouds. In this district the formation assumes a remarkable, mineral aspect; for, although it contains some subordinate beds of oolitic structure, it is in general made up of coarse concretions, which, being flattened, give to it the appearance of a nummulite rock. Numerous coralline bodies are described as being spread over the sandy, ferruginous faces of the stronger beds. Among the fossils there are many species common to other formations of the oolitic series.

(4.) The Lias formation having usually a cap of marlstone, the upper lias shale of Yorkshire being wanting, is observed to rise to heights ranging from 300 to 500 feet above the Vale of Gloucester, beneath which it has been penetrated at Cheltenham to the depth of 230 feet; so that the greatest thickness of the formation is estimated at about 700 feet.

The marlstone is best seen in the insulated hills of Robinswood and Church Down, in the first of which the principal stratum is a thick-bedded, calcareous grit, separated from a covering of sandy and ferruginous, inferior oolite by thin courses of marl and marlstone.

On Church Down, of which it constitutes the summit, the marlstone is quarried to the depth of 16 or 20 feet, in beds of hard, blue and grey calc-grit, abounding in *Gryphæa gigantea* and *Belemnites pencillatus*. In the Cotteswolds, this subformation has been detected by the author in the form of only a finely laminated, micaceous sandstone, alternating with marls, on which the springs generally burst forth after percolating through the strata of the inferior oolite—thus giving rise to the Chelt and other tributaries of the Severn, as well as to the Isis or Thames.

The upper beds of the lias, beneath the marlstone, are best exposed near the culminating part of the new London and Cheltenham road, which traverses the Cotteswolds at their lowest point, viz., about 500 feet above the sea, and where a great denudation of the overlying oolites has taken place. Here, these beds are rich in fossils,

including *Ammonites Walcottii*, *A. undulatus*, *Nucula* (nov. spe.), *Inoceramus dubius*, *Belemnites acutus*, *B. tubularis*, and *B. pencillatus*, &c. &c.

Below this point the sloping sides of the escarpments are obscured by accumulations of the detritus of the superior formations, and the same accumulations extend in the form of gravel and sand over a great portion of the low country around Cheltenham, the lias protruding in small knolls. At Cheltenham the superficial beds of the lias marls are loaded with the *Gryphæa incurva*, *Ammonites subarmatus*?, and a small species of *Ammonites*, which is very abundant, the strata being highly pyritous. Towards the base of the formation, thin bands of compact lias limestone occur; and at Comb Hill, 5 miles N.W. of Cheltenham, these dark coloured hard bands are underlaid by thick beds of white lias enclosed in thinly foliated, black shales, which are seen to be incumbent on the green and red marl of the new red sandstone, the whole dipping to the S.E.

(5.) New Red Sandstone. The author describes merely the hard green and red marl, or upper member of this formation, which is in immediate contact with the lias, on the left bank of the Severn.

*Dislocations in the Cotteswold Hills.*—Remarkable instances of disruption are exhibited in many upland coombs and valleys, where the marlstone or surface of the lias is laid bare, and the strata of the great and inferior oolites, on opposite sides of such depressions, dip in different directions and at high angles, frequently inclining inwards or below the superior masses of the hills. Seeing that the overlying slaty beds of the forest marble usually maintain their horizontality, and that the above derangements are partial, the author refers them to local subsidences, which may in many cases have been in great measure occasioned by the undermining effects of springs, acting upon the pyritiferous and decomposing beds of the lias.

*Mineral Waters of Cheltenham.*—The upper strata of water in the lias of Cheltenham containing 27 parts of chloride of sodium, and  $17\frac{1}{2}$  of sulphate of soda; whilst the water obtained by the deepest sinkings contains  $72\frac{1}{2}$  parts of the chloride of sodium, and only  $6\frac{3}{4}$  of the sulphate of soda, the author was led to believe that the true source of the sea salt in these waters is the new red sandstone. He was confirmed in this conjecture by observing that the mineral waters occurring along the edge of the escarpment where the lias is very thin and directly incumbent on the red marl, are almost pure brine springs (Gloucester, Tewkesbury, &c.). By the dip of the strata to the S.E. these salt waters must necessarily be carried to considerable depths below the town of Cheltenham; and he conceives that they are raised to their original levels by cracks and fissures, and passing through certain soft and pyritous beds of the lias, obtain their peculiar medicinal properties. Geological evidence is thus brought in support of the views of Dr. Daubeny, which explain under similar circumstances the chemical changes of muriated into sulphated waters.—See *Phil. Trans.*



II. *On the occurrence of stems of fossil plants in vertical positions in the sandstone of the inferior oolite of the Cleveland Hills.*

After a short illustration of the nature and arrangement of the different members of the oolitic series in the north of Yorkshire, for fuller details of which he refers to Phillips's *Geology of Yorkshire*, and having mentioned a vast number of new species of fossils, collected on the coast of Scarborough by Messrs. Bean, Dunn, and Williamson, the author proceeds to give a particular account of a discovery recently made by himself of the stems of *Equisetum columnare*, arranged in vertical positions in the escarpment of the lower carboniferous sandstone of the oolite at Carlton Bank, near Stokesley, Yorkshire. A similar phenomenon was first made known by Messrs. Young and Bird, and subsequently by Mr. Phillips, as respected a portion of the coast between Scarborough and Whitby; but owing to the limited field in which it was observed, nearly all geologists continued to be of opinion that the plants thus found had been accidentally collocated by drifts and currents of water. The recent discovery of these stems in an upright position in the same stratum, far in the interior, and 40 miles distant from that point of the coast where they were first noticed, induced the author of this memoir to infer that this peculiar arrangement, at points so distant from each other could not have been fortuitously produced, and that therefore these plants like those of the dirt bed in Portland\*, are still in the place of their growth. The author had observed the vertical stems in the Yorkshire coast in the year 1826; and in returning to Scarborough last summer, after making the discovery at Carlton Bank, he was confirmed in the conclusion to which he had arrived, by learning from Messrs. Williamson and Bean that all the *Equiseta* found by them in the lower sandstone and shale, since his first visit, were invariably in vertical positions. He further ascertained that the only fossil shell which had been detected in the associated strata of the lower sandstone and coal, was a fresh water bivalve; and the fine lamination of the beds indicated that they must have been formed in a tranquil manner. In the overlying formations, on the contrary, all the fossil shells are of marine origin; and although in one of them vegetable matter and coal are also found, yet the stems of the *Equisetum* are never vertically arranged as in the lower sandstone, but are confusedly mixed up with other vegetable detritus.

From these data the author concludes, that during the formation of the sandy lower oolite of Yorkshire, the dark, shale beds in which the *Equiseta* still seem to be rooted, were exposed to the atmosphere—that these stems have never been detached from the place of their growth, but have been sustained in their original positions, having been first gradually silted up, and then buried under the accumulations of an estuary, the matter in which having consolidated round them, has retained the forms of their lower parts;—that afterwards these vegetable and carbonaceous strata were covered by a sea in

\* See the abstract of Dr. Buckland and Mr. De la Beche's paper on Weymouth, p. 219.

which the shells of the middle oolite were deposited, and into which the rolled plants found in the *upper* sandstone and shale were transported.

March 28.—Colonel the Earl of Munster, F.R.S., Belgrave Street ; Robert Daun, M.D., Brompton Square, Kensington ; J. Robinson Wright, Esq., of the Trigonometrical Survey ; the Hon. William Charles Wentworth Fitzwilliam, of Trinity College, Cambridge, and Halkin Street, London ; Joshua Trimmer, Esq., Bangor ; Henry Maclauchlan, Esq., of the Trigonometrical Survey ; Rev. Frederick William Hope, of Christ Church, Oxford, and Upper Seymour Street, London ; John Cotterell Powell, M.A., Jesus College, Cambridge, and Upper Harley Street, London ; Robert Hunter, Esq., Burton Crescent ; Mr. Sergeant Taddy, of Sergeant's Inn, Chancery Lane ; Thomas Bodley, Esq., of Brunswick Terrace, Brighton ; and Captain Alexander Robe, R.E., Park Road, Regent's Park,—were elected Fellows of this Society.

A paper was first read, entitled "A Sketch of the Geology of Pulo Pinang and the neighbouring islands," by J. W. Ward, M.D., Assistant Surgeon of the Madras Establishment, and communicated by the President.

Pulo Pinang, or Prince of Wales's Island, is stated to consist of a central mountain range, with plains on the eastern and western sides. The mountains are said to be composed wholly of granite, varying in the size and the proportion of the constituent mineral ; and to be traversed by veins of quartz and finely grained granite. The plains are described as formed entirely of alluvial matter, in which no animal remains have been found. The author conceives that these plains have been gained from the sea, which, according to his opinion, once washed the foot of the mountains. Stream tin, in small quantities, is stated to occur near Amees Mills, but no veins of this mineral have been found. The sea is said to be making considerable ravages on some parts of the coast, but on others to be depositing extensive mud banks. Of the neighbouring islands Pulo Rimau, Pulo Jerajah, Pulo Ticoose, and Pigeon Island, consist of granite ; Pulo Boonting, of felspathic rocks ; Pulo Sonsong, the Pulo Kras, Pulo Kundit, of argillaceous schists ; Pulo Bidan, of limestone resting on argillaceous schist ; and Pulo Panghil, of limestone similar to that of the island last mentioned.

A paper was then read, entitled, "An attempt to bring under general geological laws the relative position of metalliferous deposits, with regard to the rock formations of which the crust of the earth is formed," by M. Albert Louis Necker, For. Mem. G. S. &c.

The author commences by remarking, that ancient writers failed in their attempts to establish fixed rules for recognizing metalliferous districts by the external configuration of the soil ; and that the laws which guide the miner in discovering new metalliferous veins in one country will often not assist him in another. He next observes that, as far as he is aware, Werner and his disciples abandoned the idea of establishing a connexion between formations and metalliferous deposits ; and that Hutton considered the connexion of veins and the rocks

through which they pass to be purely fortuitous. He then states, that he believes Dr. Boué\* was the first to point out, in a general manner, the relative position of metalliferous veins and primary unstratified formations; and thus to lead to the inference, that the metals were deposited in the former by sublimation from the latter: and he adds, that Baron Humboldt† accounts for the association of the mines of the Oural and Altai mountains with granite, porphyry, and syenite, by supposing all of them to be the effect of volcanic agency, taken in its most extended signification.

This doctrine, the sublimation of the metalliferous contents of veins from igneous matter, the author states, occurred to him twelve years ago, from observing the deposition of specular iron on the crust of a stream of lava flowing down the side of Vesuvius; and he was induced from that circumstance to institute a series of inquiries, and in further prosecution of the subject, he proposes in the memoir the following questions:—

1st, Is there near each of the known metalliferous deposits any unstratified rock?

2ndly, If none is to be found in the immediate vicinity of such deposits, is there no evidence, derived from the geological constitution of the district, which would lead to the belief that an unstratified rock may extend under the metalliferous district, and at no great distance from the surface of the country?

3rdly, Do there exist metalliferous deposits entirely disconnected from unstratified rocks?

With respect to the first of these questions, the author shows, by copious references to works on England, Scotland, Ireland, Norway, France, Germany, Hungary, the southern Alps, Russia, and the northern shores of the Black Sea, that the great mining districts of all these countries are immediately connected with unstratified rocks: and in further support of this solution of the first question, he mentions the metalliferous porphyries of Mexico, and the auriferous granite of the Orinoco; but he observes that his knowledge of the mining countries of South America is not sufficient to enable him to state their general geological connexions.

With reference to the second question,—the probable association of metallic veins with unstratified rocks, though the latter are not visible in the immediate neighbourhood of the former;—the author gives a section of the country between Valorsine and Servoz, and points out the probable extension of the granite of Valorsine under the Aiguilles Rouges and Breven, composed of protogine, chlorite, and talcose schists, to the immediate vicinity of the mines of Servoz, which are situated in the latter formation. He also refers the reader for further illustration to the metallic deposits of Wanlockhead and the Lead-hills; to the mines of Huelgoet and Poullavaen in Brittany; to those of Macagnaga and Allayna at the foot of Mount Rosa, of Cardinia, Corsica, and Elba; to the metalliferous veins of the Vosges,

\* *Mémoire Géologique sur l'Allemagne.*

† *Essai de Géologie et de Climatologie Asiatique.*

Brescia in the Alps, and the Altai chain ;—all of which occur in districts where unstratified rocks are known to exist.

The author, however, states that besides the evidence thus afforded of the connexion of igneous rocks with metalliferous deposits, it is necessary to have a knowledge of the stratification of the formations in which mines are worked before any legitimate conclusion can be drawn.

In reply to the third question,—Do there exist metalliferous deposits entirely disconnected from unstratified rocks ?—The author enumerates the mines of the Netherlands ; those of quicksilver at Idria ; the lead mines of Poggau in the valley of the Mur ; Pezay and Macoz in the Tarentaise ; and the veins of galena in the mountain-limestone of the south-west of England.

The author then gives, as a general illustration of his subject, a sketch of the countries between the Alps and the western extremity of England, and shows that igneous rocks and metallic deposits are totally wanting in the whole of the districts extending from the foot of the Alps across the valley of Lac Leman, the Jura chain, the plains of Franche Comte and Burgundy ; and in the oolitic, green-sand, chalk and tertiary formations of the north-west of France, and in the tertiary and secondary formations of England as far as Devonshire ; but that, on the contrary, as soon as the unstratified rocks recommence in the last-mentioned district, metallic veins reappear.

Lastly, the author compares the relative connexion of igneous deposits with metallic accumulations, and states that ores are more abundant in granite, certain porphyries, syenites, amygdaloids, and trap, which he calls underlying, unstratified rocks, than in the newer porphyries, the dolorites, and the true volcanic formations, which he distinguishes by the term of overlying, unstratified rocks ; and he alludes to the assistance which the practical miner would derive from attending to this distinction, and to the principal object of the paper, —the connexion of igneous with metalliferous deposits.

April 11th.—Peter Frederick Robinson, Esq., Lower Brook-street, was elected a Fellow of this Society ; and the name of John Buddle, Esq. was removed, by ballot, from the honorary to the ordinary list of Fellows.

A Letter from George Gordon, Esq., addressed to Roderick Impey Murchison, Esq. P.G.S., noticing the existence of lias on the southern side of the Murray Firth, was first-read.

Mr. Gordon, after referring to the memoir of Professor Sedgwick and Mr. Murchison on the North of Scotland, in which lias is shown to occur on the northern side of the Murray Firth, points out the existence at Linksfield or Cutley-hill near Elgin, of a stratum of clay inclosing thin bands of limestone, and occupying a position analogous to that of the lias on the northern side of the Firth. Mr. Gordon likewise states, that in making the canal to drain Loch Spynie, a bed of clay was penetrated containing numerous specimens of Belemnites ; and he conceives that a great part of the bay of Lossiemouth belongs to that formation.

A paper was then read “ On the strata in the immediate neigh-

bourhood of Lisbon and Oporto," by Daniel Sharpe, Esq. F.G.S. & F.L.S.

Lisbon is shown, by the author of this memoir, to stand upon a range of hills divided by a narrow valley or ravine. The eastern division of the range is stated to be composed of tertiary deposits, and the western of a limestone containing Belemnites.

The superior bed of the tertiary formations consists of sand in which no fossils were observed, and is about 150 feet thick. It does not occur in Lisbon, but appears on the south side of the Tagus, forming part of its bank and the summit of the neighbouring hills.

To this bed succeeds a series of strata from 200 to 300 feet thick, and composed of alternations of sand and rubbly, arenaceous limestone, containing in great abundance shells of the genera *Ostrea*, *Pecten*, *Venus*, *Fistularia*, *Turritella*, *Cerithium*, *Balanus* and *Serpula*. The limestone appears on both sides of the Tagus, and though of a perishable nature, is employed as a building material.

The lowest visible portion of the tertiary series is a bed of blue clay, which also succeeds many organic remains.

The belemnitic limestone is a finely-grained hard rock, occasionally used as a marble, and contains, though rarely, layers of black flints similar to those which are found in the Portland oolite. This limestone forms extensive tracts in the neighbourhood of Lisbon, and constitutes a part of the abrupt escarpments along which the far-famed lines of Torres Vedras were constructed.

The next formation, in a descending order, is a deposit of sand and sandstone, in which no organic remains were noticed. It appears to the north and east of Lisbon, and at Villa Franca, where it underlies the belemnitic limestone. The celebrated springs of Caldas burst forth in this formation.

Beneath the sandstone last mentioned, the author observed at Villa Nova da Reinha, to the north of Lisbon, another bed of limestone; but he gives no details respecting its nature.

The next formation described in the memoir is an extensive deposit of basalt, which is stated to occur in contact both with the tertiary series and the belemnitic limestone, but to have produced no change on these strata at its junction with them.

The granite of the hill of Cintra is said to be composed principally of quartz and felspar with a small proportion of mica and hornblende, and to be divided into large blocks by natural lines of cleavage. On the north side of the hill a limestone is stated to rest against the granite, and on the east a deposit of shale, and the strata of these formations to be highly inclined.

The author next proceeds to describe the structure of the neighbourhood of Oporto. The city stands upon a low ridge of granite, cut through by a defile in which the Douro flows. The granite, composed of quartz, felspar, mica, and hornblende, in the immediate vicinity of Oporto is hard, but at a short distance from it, is decomposed even to a considerable depth beneath the surface.

To this formation succeeds a granitic gneiss, the strata of which dip at a considerable angle from the granite, and extends on the west

of Oporto to the mouth of the Douro, and on the south and the east for several miles. On the gneiss, in the direction of Vallongo, reposes chlorite slate, the strata of which are stated to be inclined at a very high angle. The next deposit, resting conformably on the last, consists of alternate beds of anthracite and conglomerate, derived from the rocks already enumerated; and to these strata chlorite slate again succeeds, forming the range of hills called the Serra de Vallongo. In this part of the series veins of metalliferous quartz occur, containing ores of antimony and silver. To the east of the Serra de Vallongo the chlorite slate is overlaid by a dark blue argillaceous schist. Beyond this point the author's observations did not extend.

An Essay "On the Curvilinear Structure of Lava," by Signor Monticelli of Naples, was afterwards read.

The object of the author is to attract the notice of geologists to a peculiarly beautiful and symmetric arrangement which he has observed in the lava of La Scala, one of the largest and most ancient currents of Vesuvius. The existence of numerous perpendicular and horizontal fissures which traverse this lava, and sometimes give it the appearance of regular stratification, was described by Breislac; and the same observer noticed its tendency to split, under the hammer, into irregular prisms of an hexagonal figure. But a far more symmetric arrangement was recently discovered in a grotto opened by the workmen in quarrying the lava. The walls of lava bounding this grotto were distinctly curvilinear; several distinct curvilinear strata were traced with their seams parallel to each other; and the grotto itself, decreasing in height and width towards either extremity, possessed the form of an ellipsoid. The author describes another similar arrangement of the lava at the same locality, consisting of not fewer than fourteen successive, parallel strata of a spherical form, arranged one above the other in such a manner as to present the outline of an inverted, truncated cone.

The author, after referring to similar though less perfectly developed curvilinear arrangements which have been seen in lava and basalt in other situations, throws out suggestions as to the cause of these remarkable appearances. He objects to the opinion of Breislac, that the vertical and horizontal fissures noticed by him are referrible to contraction produced by the sudden cooling of a heated mass; and he adduces an instance of a lava current having flowed into the sea, and been thereby subject to most rapid refrigeration, without possessing the least fissure in its substance. The author believes that the production of fissures, of prismatic forms, and of the curvilinear arrangements, in lava and basalt, depends on uniform forces of attraction acting on the mass while in a fluid condition. He appeals, in particular, to the spherical, elliptic, and parabolic forms observed by himself in proof of the agency of central points of attraction having acted on surrounding particles, and influenced their arrangements.

PROCEEDINGS  
OF  
THE GEOLOGICAL SOCIETY OF LONDON.

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1832.

No. 27.

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May 2.—Thomas Baker, Esq., Wilton Place, and Capt. Jones, R.N. M.P. Curzon Street, were elected Fellows of this Society.

A paper was read, "On the Geological Structure of the North-eastern Part of the County of Antrim," by James Bryce, Jun. Esq. M.A. Member of the Belfast Natural History Society, &c., and communicated by Roderick Impey Murchison, Esq. P.G.S.

In this memoir the author enters into a minute description of the physical features and geological constitution of a portion of the district, described by Dr. Berger, and by Dr. Buckland and Mr. Conybeare in the third volume of the first series of the Geological Society's Transactions.

After alluding to the labours of these celebrated observers, the author defines the extent and physical features of the district described in his memoir. He states that it is bounded on the west by the escarpment of the chalk from Kenbaan Head to Corky; on the south by a line drawn from that place to Gerron Point; and on the east and north by the Irish Sea. The area, thus circumscribed, is traversed in a N.W. direction by the Aura mountains, from the southern part of which several, long, projecting ridges with flat, broad summits and precipitous sides, branch off; and in the northern part of the district the surface is occupied by detached hills, having a direction parallel to that of the main chain. The height of the principal mountains varies from one thousand to two thousand feet. Their eastern declivity is abrupt, but their western is formed by a succession of undulating hills, which gradually descend into the low country extending from Kenbaan Head to Corky.

The principal formations described, are mica-slate, porphyry, old red sandstone, carboniferous limestone, coal measures, new red sandstone and conglomerate, lias, mulatto or green sand, chalk, and trap.

*Mica-slate.*—This formation is stated not to differ from the characters assigned to it by Dr. Berger in other parts of the North of Ireland. The subordinate strata which it contains, are limestone, compact felspar, porphyry, and hornblende rock; granite is also said to form a bed in it near the village of Ardsilloch. It occupies nearly the whole of the central area of the district described in the memoir, being covered at only four points by beds of chalk and basalt. The strata dip invariably to the eastward, and generally at a high angle.

*Old red sandstone.*—This deposit is of very limited extent, being confined, by the author, to a narrow band ranging from Cushendan Church to Ballyeemin Glen; and he is of opinion that the district as-

signed to it by Dr. Buckland and Mr. Conybeare on the shore of Cushendan Bay, belongs to a conglomerate associated with the new red sandstone. It is described as consisting principally of a coarsely grained, whitish sandstone, containing in its upper part fragments of quartz and porphyry, but no pebbles of granite or mica-slate. It is stated to alternate both with the subjacent mica-slate and the superincumbent new red conglomerate, and it is said to contain also beds of porphyry. The strata dip conformably to those of the mica-slate, but the angle of inclination gradually decreases from  $65^{\circ}$  to  $30^{\circ}$  as the formation recedes from the latter rock.

*Porphyry.*—Several varieties of this rock are stated to occur, the most common having a claystone base. The author conceives, as it frequently alternates with the old red sandstone, but never with the new red conglomerate, that it constitutes the essential character by which these deposits may be distinguished from each other.

*The carboniferous limestone*—is merely alluded to as occurring on the sea shore near Fairhead.

*The coal measures*—are stated to consist of the usual alternations of coal, shale, sandstone, and ironstone; to rest at their northern boundary on the mountain limestone and old red sandstone; and at their southern on mica-slate; and to be overlaid by the great basaltic deposit of Fairhead.

*New red sandstone and conglomerate.*—The conglomerate occurring on the shore of Cushendan Bay, the author separates from the old red sandstone to which it had been previously assigned, and considers it as a member of the new red sandstone. His reasons for making this separation are, that it is identical in character with the conglomerate which overlies the coal measure in Murloch Bay; that it contains pebbles of granite and mica-slate, which are never found in the old red sandstone; that the latter formation alternates with mica-slate, but that the conglomerate when in contact with that rock, does not alternate with it, but reposes unconformably upon it; and that the old red sandstone contains beds of porphyry which are never found in the conglomerate. The author, however, states that the conglomerate alternates with the old red sandstone as well as with the new red sandstone; and he admits that the whole series of strata between the mica-slate and the chalk must be regarded as one great mechanical deposit, produced by the operation of the same cause, occasionally modified in intensity.

The upper division of this formation consists of the usual varieties of red sandstone and red marl with gypsum.

*Lias*, the next stratum described, consists entirely of shale, and occurs only on the southern shore of Cushendan Bay.

*The mulatto* is divided by the author, in conformity with the characters assigned to it by Dr. Berger, into two parts,—the upper consisting of a homogeneous sandstone, and the lower of a conglomerate containing quartz pebbles, and fragments of mica-slate and white limestone. These two varieties are said to be constant in their characters and position, and to form a band varying from 9 inches to 10 feet in thickness from Gerron Point to Teabuliadh mountain.



*Chalk.*—This formation is extensively displayed resting in horizontal strata on the highly inclined beds of mica-slate, and is for the greater part overlaid by basalt. No additional characters, to those already published, are given by the author, but he points out that the boundaries which have been hitherto assigned to it are far from correct.

*Trap.*—The history of this rock, the author says, has been so completely investigated in all its relations, that he has no new facts to communicate regarding it; he, however, notices the occurrence of several important dykes, some of which pass through the conglomerate beds of the new red sandstone, without penetrating the strata which rest upon them.

Lastly, the author alludes to the enormous extent to which the chalk and superincumbent basalt have been denudated in this portion of Ireland, leaving only four isolated monuments within the area of the district, to prove their former extension over the whole of its surface; and he enumerates several instances of the rapid destruction of the cliffs along certain portions of the coast, and of the accumulation of detritus at the mouths of all the rivers.

May 16.—James Mitchell, Esq. of New Broad Street, was elected a Fellow of this Society.

A paper "On the Geological Relations of the stratified and unstratified Groups of Rocks composing the Cumbrian Mountains," by the Rev. Adam Sedgwick, V.P.G.S. F.R.S. Woodwardian Professor in the University of Cambridge, was read.

#### Chap. I.—*Introduction.*

The author first shows, that the limits of the region to be described, are defined by a zone of carboniferous limestone, based here and there upon masses of old red conglomerate. This zone is described as entirely unconformable to the central system, and for the phenomena presented at the junction of the two great classes of rocks, he refers to previous memoirs read before the Society.

The rocks of the central system are separated into stratified and unstratified; and the stratified are divided into four distinct groups, in the following descending order:

1. Greywacke and greywacke-slate; the whole group based on beds of limestone and calcareous slate, and bounded at its upper surface by a part of the carboniferous zone.

2. A great formation of quartzose, chloritic, roofing slate and felspar porphyry; alternating in great, irregular, tabular masses, each passing into, or replacing, the other; the whole having nearly a constant strike, and dip similar to that of the preceding group.

3. Skiddaw slate—a very fine, dark, glossy clay-slate, occasionally penetrated by quartz veins, sometimes passing into a coarse greywack and greywacke-slate.

4. Crystalline slates between the preceding group and the central granite of Skiddaw Forest.

It is then shown, that the mineralogical axis of the whole region may be placed in the direction of a line drawn from the centre of Skiddaw Forest to Egremont, and that on the north side of this line

the second group reappears immediately under the carboniferous zone, forming a band which gradually thins off, and disappears below Cockermouth.

The unstratified groups are then enumerated as follows :

1. Granite of Skiddaw Forest, the true mineralogical centre of the whole region.

2. Carrock Fell syenite, irregularly traversing and overlying the third and fourth stratified groups, and apparently underlying the second.

3. A great formation on the S.W. side of Cumberland, composed of syenite, porphyry, and granite, which breaks through between the second and third groups, penetrating, traversing, and overlying the third, but never overlying the second.

4. Shap granite, breaking through, between the first and second great, slaty groups, and cutting off the range of the fossiliferous limestone by which they are separated from each other.

5. Granite veins ; porphyritic dykes, having the relations of the Cornish elvans ; common trap dykes : these are found associated with all the stratified groups.

#### Chap. II.—*Successive stratified groups.*

§ 1. *Greywacke and greywacke-slate.*—This group is subdivided as follows, in descending order :

1. Coarse greywacke and greywacke-slate, occasionally with organic remains, but with no beds of limestone.

2. Finer greywacke-slate, thrown into great undulations, but having a prevailing strike about N.E. by E.

3. A band of calcareous slate and fossiliferous limestone, ranging from the hills north of Dalton to Coniston-water-foot.

4. A broad zone of greywacke-slate, having generally a strike about N.E. by E. and a dip S.E. by S. at an angle varying from 30° to 45°. From this zone masses of roofing slate are commonly derived by a cleavage transverse to the plane of stratification.

5. Calcareous slate and limestone, ranging from the south-western extremity of Cumberland till it is cut off by the Shap granite. Its range, and the evidence it offers of great dislocations, have been described in a previous memoir (see pp. 247, 318).

§ 2. *Green slate and porphyry, &c.*—This great group, which occupies all the highest and most rugged mountains of the region described in this memoir, is essentially composed of great, tabular masses (having generally the same strike and dip as the lower beds of the preceding group), composed of different modifications of porphyritic and felspathic rocks, and of quartzose and chloritic slate, all the finer portions being derived from a cleavage transverse to the stratification of the beds. The modifications of the slate are first described, and it is shown that they pass, on one hand, into compact felspathic slate sometimes porphyritic ; on the other, into coarse granular and concretionary slaty masses, and through them into breccias, or pseudo-breccias, all these changes being effected without any change of strike or dip. In like manner it is shown that the amorphous, and even semicolumnar, prismatic, porphyries are not only

arranged in directions parallel to the tabular masses of green roofing slate; but pass themselves into a slaty texture with a strike and dip parallel to those of the true roofing slate. They also pass into brecciated masses similar to those which form a part of the slate groups. From these facts,—as well as from the negative facts, that the porphyries never penetrate the roofing slate in the form of dykes, and produce no mineral change in the limestone beds resting on them,—it is inferred that the whole group is of one formation, which has originated in the simultaneous action of aqueous and igneous causes long continued.

§ 3. *Skiddaw slate*.—The author briefly describes the range and extent of this group, its position below the preceding, and some of its mineral changes from fine, glossy, clay-slate, much penetrated by quartz veins, into, though rarely, very coarse greywacke. It does not generally effervesce with acids, and contains no organic remains: it is chiefly distinguished from the first group above described, by these negative properties, and by its being of finer texture.

§ 4.—*Crystalline slaty rocks* in the central portions of Skiddaw Forest, *immediately* between the preceding group and the central granite.

This group is described as being irregular in its order and ill exposed, but from the comparison of a series of sections appears to be separable into the following subdivisions.

(1.) Skiddaw slate with interspersed crystals of chialtolite, alternating with and passing into the preceding group.

(2.) A similar slate with numerous crystals of chialtolite, passing in the descending order into a crystalline slate sometimes almost composed of matted crystals of chialtolite.

(3.) Mica slate spotted with chialtolite.

(4.) Quartzose and micaceous slates sometimes passing into the character of gneiss.

With this group the paper terminates: but the author promises to resume the subject, and describe, in order, first the several unstratified masses above enumerated; and then the changes produced by the protrusion of the unstratified masses, both on the position and mineral character of the several stratified groups.

May 30th.—A paper was first read “On the Basalt of the Titterstone Clee Hill, Shropshire,” being the concluding part of a memoir on the Ludlow district, laid before the Society on the 29th of February, by J. Robinson Wright, Esq., F.G.S. employed on the Ordnance Trigonometrical Survey.

The basalt occupies the two highest points of the hill, called the Giant’s Chair and the Hoar Edge, which are separated from each other by a narrow ravine. It rests partly upon the old red sandstone, and partly upon the coal measures; and occasionally assumes a columnar structure,—the prisms inclining at an angle of  $75^{\circ}$ . Besides these overlying masses a basaltic dyke has been ascertained to cut through and greatly affect the coal measures; and the author suggests that the outburst of this dyke may, from its direction, possibly form the north-westerly escarpment of the Hoar Edge.

The author, in conclusion, compares the Titterstone basalt with the trap of Rowley Regis, and points out their agreement in geological position and mineralogical structure.

A paper was then read "On a large Boulder-stone on the Shore of Appin, Argyleshire," by James Maxwell, Esq., and communicated by William Smith, Esq., F.G.S., F.R.S., &c. &c.

This boulder-stone consists of a granitic compound of quartz, felspar, and mica; the last mineral being the principal ingredient. Its form is irregular, but the angles have been rounded. The greatest vertical circumference is forty-two feet, and the greatest horizontal thirty-eight feet. It is supported on three smaller stones, each about six inches thick; one of them being a granite of a paler colour than that which composes the boulder itself; and the other two consisting of argillaceous ironstone. The formation on which the supports rest is a slaty, calcareous sandstone. Numerous other granitic boulders occur in this part of Scotland, but no rock *in situ* from which they could have been derived.

A third paper was read "On the Discovery of Bones of a Rhinoceros and a Hyæna in one of the Cefn Caves, situated in the Vale of Cyffredan, Derbyshire," by the Rev. Edward Stanley, F.G.S., &c.

The author commences his memoir by describing the physical features of the district, and the present mode by which its waters are drained. He then shows that if the pass between the Cefn and Galltfaen cliffs were filled up, the river Elwy would be converted into an extensive lake which would occupy the vale of Cyffredan, on the eastern side of which the Cefn caves are situated. The lowest cave, raised but a few feet along the level of the river, forms a natural archway penetrating through the limestone cliff and affording a passage for a road. In its lateral ramifications, human bones, the horns of a deer, and works of art have been found, but no remains of extinct animals. About one hundred feet above the level of the valley, two other caves are situated in the face of the precipitous, limestone cliff; but only one of them has been examined, and it is to this cave that the memoir in particular refers. When it was first discovered, the interior, from the level of the entrance to a short distance from the roof, was occupied by calcareous loam, in which a few angular masses of limestone, part of the humerus of a rhinoceros, teeth of a hyæna, and numerous fragments of bones were found. Beneath this accumulation, and beneath what had been considered the floor of the cave, the author ascertained the existence of another deposit of similar loam; but containing, besides, fragments of bones and small portions of wood, rounded pebbles of greywacke.

The cave was found to have several branches, one of which was traced, in a southern direction, through the hill till it terminated in the face of the escarpment opposite the Galltfaen cliff; but the real extent of the other branches has not been determined.

The author, after these details, enters into an inquiry respecting the former physical structure of the district, and the mode by which the contents of the cave were deposited in the position in which they were found. He conceives that either the vale of Cyffredan was

formerly occupied by a lake, or that the surface of the vale was once nearly on a level with the entrance of the cave : and he explains the position of the loam and associated pebbles and bones by supposing that a sudden flood, rushing through the valley, carried into the cave the pebbles, fragments of wood, and loam found in its lower part :—that after this inundation no similar catastrophe occurred for an unknown period, during which the caves again became the resort of wild animals :—that at the close of that period another and more powerful flood occurred, rising above the level of the caves, and depositing within it, the loam which occupied the greater part of its cavity ; and that this flood, overcoming every obstacle, excavated the valley to its present depth.

The memoir was illustrated by numerous drawings of the caves and bones, a ground plan, and a manuscript map of the district.

June 13.—William Henry Egerton, Esq., of Oulton Park, Cheshire ; Bridgeman More, Esq., of Lindley Hall, Shropshire ; George Mercer, Esq., Queen Ann Street West ; Edward Hawkins, Esq., of Street near Glastonbury ; Thomas Watson, M.D., late Fellow of St. John's College, Cambridge ; Lieut. Col. Hugh Montgomery ; and Edward Hussey, Esq., Park Street, Grosvenor Square,—were elected Fellows of this Society.

A paper was first read, entitled “ Observations on the London Clay of the Highgate Archway,” by Nathaniel Wetherell, Esq., F.G.S.

This communication, which was accompanied by a series of specimens, gives a full account of the position, extent, and order of the beds cut through in making the excavation for the archway, and a list of the fossils found in the lowermost stratum or the London clay.

For the details respecting the order of the beds the author refers to the “ Outlines ” of the Rev. William Conybeare and the late Mr. Phillips ; and after enumerating the fossils found in the clay, points out that the species of most common occurrence were *Pectunculus decussatus*, *Natica glaucinoides*, *Modiola elegans*, and *Teredo antenauta*, and that those of rarest occurrence were *Acteon elongatus*, *Cypræa oviformis*, *Neritina concava*, and *Serpula crassa*.

A paper was afterwards read giving “ An account of the Discovery of portions of three Skeletons of the Megatherium in the province of Buenos Ayres in South America,” by Woodbine Parish, jun. Esq., His Majesty's Chargé d'Affaires and Consul General at Buenos Ayres ; followed by a description of the bones by William Clift, Esq. F.G.S. F.R.S. &c. &c.

Mr. Parish some years since presented to the Geological Society several large bones of mammalia, discovered in the valley of Tarija on the confines of Bolivia, and being anxious to procure further specimens, he instituted a series of inquiries, by which he ascertained that the teeth and bones of quadrupeds had been frequently met with in the province of Buenos Ayres, especially in the neighbourhood of the river Salado, and in the beds of its tributary lakes and streams ; as well as in the adjoining province of Entre Ríos, and that in the Banda Oriental a nearly perfect skeleton was once found.

During these inquiries Mr. Parish was informed that some bones

of extraordinary size had been found in the bed of the Rio Salado, and brought to Buenos Ayres from the Estancia of Don Hilario Sosa. On inspecting them he was immediately struck with their resemblance to the remains of the *Megatherium* formerly sent to the Museum at Madrid by the Marquis of Loreto, and likewise procured in the province of Buenos Ayres. These bones, the property of Don Hilario Sosa, consisted of a pelvis, nearly perfect, a thigh bone, several vertebræ, five or six ribs, and four teeth. After much solicitation Mr. Parish became possessed of them, and in the hopes of procuring the remainder of the skeleton, he deputed Mr. Oakley, a gentleman of the United States, to make the necessary investigations.

Mr. Oakley soon ascertained that other bones were imbedded in the mud at the bottom of the river, and by diverting, in part, the course of the stream, he succeeded in obtaining a scapula, an os femoris, five cervical vertebræ, several teeth, and numerous other bones which were too much decayed to be preserved.

Besides these valuable remains Mr. Oakley procured parts of two other skeletons of the *Megatherium*; one of them from a small rivulet near Villanuéva, and the other from the banks of the lake at Las Aveiras. Both these skeletons were accompanied by a thick osseous covering, or shell, considerable portions of which were preserved, and one part of the collection sent to England by Mr. Parish.

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The preceding history of the discovery of the bones of the *Megatherium*, was succeeded by an enumeration and description of them, by Mr. Clift; from which it appears that the parts of the skeleton brought to England by Mr. Parish, although comparatively much less numerous and complete than those in the specimen preserved in the Royal Cabinet at Madrid, fortunately include several essential parts which are deficient in that specimen; and that consequently from the discovery of these remains, the history of the animal will be much improved. Of the hitherto undescribed parts, the structure of the teeth,—the existence of the pubis and ischium,—and a large proportion of the caudal vertebræ, are the most important and essential additions to our previous knowledge of this most singular and stupendous creature.

PROCEEDINGS  
OF  
THE GEOLOGICAL SOCIETY OF LONDON.

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1832-1833.

No. 28.

Nov. 7, 1832.—The Society assembled this evening for the session. Woodbine Parish, Jun. Esq. F.R.S. of Upper Harley Street; Henry Trollope, Esq. of Harrow; Whitlock Nichol, M.D. F.R.S. & L.S. of Curzon Street Mayfair; and Herbert Mayo, Esq. F.R.S. Professor of Anatomy in King's College, London, were elected Fellows of this Society.

A paper was first read, "On some Intersections of Mineral Veins in Cornwall," in a letter to Davies Gilbert, Esq. M.P. F.G.S. F.R.S. &c., by William John Henwood, Esq. F.G.S.

The chief object of this communication is to lay before the reader particular facts bearing upon certain theories respecting the dislocation of veins; and the author in pursuance of his intention first states the theory as a question, and then adduces his facts. The following are the principal propositions.

1. When one vein is dislocated by another, is it to be found on the side of the smaller or larger angle?

At Bulls, in the Herland mine, two veins are heaved by a cross-course; and one of them was rediscovered on the side of the smaller angle, and the other on the side of the larger angle.

2. When one vein dislocates several others, are all the latter to be found on the same hand?

In the Weeth mine, two cross-courses are traversed by the same E. and W. lode. One of them is heaved to the left, the other to the right, but both to the side of the larger angle.

3. When the same vein is dislocated by several others, do they all heave it to the side of the greater, or all to the side of the smaller angle?

In Huel Friendship mine, a lode has been heaved by three cross-courses, in each instance to the left; but in two, on the side of the smaller, and one on the side of the greater angle.

4. When a vein is dislocated by several others, do they all heave it to the right, or all to the left; or some one way, some the other?

In Carharrack mine the lode is heaved by two cross-courses, and by both of them to the side of the larger angle; but in one instance to the left, and in the other to the right.

5. When a vein is thrown or dislocated by a slide, is it to be rediscovered on the side of the greater or smaller angle?

In South Huel Towan mine, the vein was rediscovered on the side of the smaller angle; but at Bulls on that of the larger angle.

6. When the same lode is dislocated by various slides, do all the latter throw it to the side of the greater angle, or all towards that of the smaller ; or some to one, and some to the other ?

In Huel Peever mine are two lodes and two slides ; both the lodes are thrown down by one of the slides, and towards the greater angle ; but one of the lodes, (*a*) on coming in contact with the other lode (*b*) is thrown upwards or towards the smaller angle, and the same lode (*a*) on meeting the slide (*d*) is again thrown upwards or to the smaller angle.

7. When various veins are thrown by the same slide, does it throw them all upwards or all downwards, or some upward and some downward ?

In Huel Trevaunance mine some of the veins on coming in contact with others are thrown down ; but one of the veins (*a*) on coming in contact with the vein (*f*) is thrown upwards ; and the vein (*b*) on coming in contact with the vein (*f*) is also thrown upwards, as is the vein (*f*) on coming in contact with the vein (*e*).

The author having thus “ compared the general rules, which are so frequently discussed, with facts,” says, “ Notwithstanding there are numerous exceptions, it may be assumed that where a cross vein is found to have heaved two or three lodes towards one hand, the miner will not often be very far wrong if he excavate in the same direction to recover a dislocated portion of a fourth ;” and the author further observes, that he shall not be surprised if a different rule be found to prevail in the districts where tin abounds, from that which obtains in a copper country. He next proceeds to combat the received opinion, that all interruptions or intersections in mineral veins are the effects of disturbances, and that the order of intersection of the various veins is the index of their relative age.

He states that the only extraneous evidence of motion in veins is the existence of slickensides ; but he says, that in Huel Robert mine the slickensides traverse the substance of the vein in every direction, and in almost every possible variety of form ; that in many other instances he has seen on the plane surface very considerable prominences ; that the striæ were marked not only on the plane surface, but also on the elevated portions ; that many of the striæ on the walls of the veins are converging, and that in numerous instances on opposite sides of the same vein they dip different ways.

The author then enters upon the inquiry whether the phenomena of intersections and dislocations are explicable on the assumption of motion. He states that horizontal motion will not account for a vein being heaved to the right by one vein and to the left by another, or even both the same way but to different distances. With respect to oblique motion he says, that there are many instances of a lode being heaved towards one hand at one depth and to the opposite at another depth ; and lastly, with respect to vertical motion he says, that if two lodes, dipping the same way, be dislocated by the same cross-course, they will be heaved towards the same hand, but if they dip different ways they will be heaved to opposite hands ; he, however, states, that at Huel Trenwith mine two veins dipping different ways are traversed by



a cross-course, but are both heaved towards the right or to the same hand.

A Notice of a Submarine Forest in Cardigan Bay, by the Rev. James Yates, M.A. F.G.S. and L.S. was afterwards read.

This forest extends along the coast of Merionethshire and Cardiganshire, being divided into two parts by the estuary of the river Dovey, which separates those counties. It is bounded on the land side by a sandy beach and a wall of shingles. Beyond this wall is a tract of bog and marsh formed by streams of water which are partially discharged by oozing through the sand and shingles. The author argues that, as the position of the wall is liable to change, it may have inclosed the part which is now submarine, and that it is not necessary to suppose a subsidence effected by subterranean agency.

The remains of the forest are covered by a bed of peat, and are distinguished by an abundance of *Pholas candida* and *Teredo navalis*.

Among the trees of which the forest consisted is the *Pinus sylvestris*, or Scotch fir; and it is shown that this tree abounded anciently in several northern counties of England. The natural order of *Coniferae* may thus be traced from the period of the independent coal formation to the middle of the seventeenth century, although the Scotch fir is now excluded from the native Flora.

The amentaceous wood presents matter for reflection, in consequence of the perfect preservation of its vascular structure, while the contents of the vessels are entirely dissipated.

This tract is known to the Welsh under the name of *Cantrev Gwaelod*, i. e. the Lowland Hundred. The author refers to the Triads of Britain, and to other ancient Welch testimonies, which prove that it was submerged about A.D. 520, and ascribe the disaster to the folly of "Seitheryn, the Drunkard, who in his drink let the sea over the Cantrev Gwaelod."

A paper entitled "Notices on the Geology of the North-west of the Counties of Mayo and Sligo," by the Venerable Archdeacon Verschoyle, and communicated by Roderick Impey Murchison, Esq. P.G.S. was also begun.

Nov. 21.—George Wilbraham, Esq. M.P., Upper Seymour Street; Francis Jervoise Ellis, Esq. B.A. of King's Bench Walk, Temple; George Bentham, Esq. F.L.S. and Sec. Hort. S.; and Jedediah S. Tucker, Esq. of Tremarton Castle, Cornwall, and Pump Court, Temple; were elected Fellows of this Society.

The reading of Archdeacon Verschoyle's paper, begun at the meeting held on the 7th of November, was concluded.

The author divides his memoir into two parts; in the first he gives a topographical description of the country, and in the second a detailed account of the different formations of which it is composed.

I. The district described is situated in the western part of the province of Connaught, and is bounded on the N. and W. by the Atlantic. Through the eastern portion a primary chain, called the Ox mountains, having a mean height of 1300 feet, extends in a N.E. and S.W. direction. The north side of the chain rises at a considerable angle, and terminates in a series of abrupt, rocky peaks; but the plane which forms the southern declivity is much more gradual in its inclination.

The principal passes are at Colloony, Lough Talt, and Foxford. The formations of which the mountains consist are mica-slate, hornblende-slate, and quartz rock. Their bases are covered by a conglomerate which the author considers to be the representative of the old red sandstone; and on it repose alternating strata of sandstone, and shale, succeeded by carboniferous limestone. On the south of the chain the limestone stretches towards Roscommon and Galway, joining the great limestone field of Ireland; and on the N.W. it forms a plain, extending from Sligo to the barony of Erris, where the Nephin group rises from beneath it, being the commencement of the primary tract reaching northward and westward to the ocean. Immense ridges of water-worn pebbles occur in every portion of the district. The coast presents for the greater part bold, abrupt precipices, formed of gneiss, mica-slate, quartz-rock, and mountain limestone; but in some places it is low, and composed of a succession of sand hills.

II. In describing the formations comprising the district, the author arranges them in the following descending order,—Carboniferous limestone with beds of oolite, calcareous shale and grit, old red sandstone or conglomerate, quartz-rock, gneiss, mica-slate hornblende-slate, granite, trap-rocks, porphyry, and basalt.

1. *Carboniferous limestone with beds of oolite*.—This is the prevailing rock on the north and south sides of the Ox mountains. Benbulbin, 1700 feet, Knocknodie, 1025, and Knocknashee, 980 feet high, are entirely composed of it. The lower beds contain black chert, in angular nodules, and it frequently invests the organic remains. The limestone varies in texture from compact to crystalline, and in colour from grey to greyish brown. Arragonite, fluor spar, brown spar, pyrites, and quartz crystals are sometimes found in it. The mineral veins have been almost entirely neglected, only one near Ballisadere, containing galena and blende, having been wrought. The organic remains are numerous, the principal genera being *Caryophyllia*, *Productus*, and *Spirifer*. In the hill of Skreen, among the lower beds, are thin layers of quartz pebbles, cemented by lime; but beneath them are other strata without pebbles.

The oolitic strata occur only between Moyne and Rathrea, and are stated to lie below the limestone. They afford a durable building material, take a tolerable polish, and contain comminuted fragments of marine exuviae, and also (though rarely) carbonized vegetable remains. Nodules of black shale, inclosing particles of pitch coal, are likewise found in these strata, and between the beds are partings of brown shale.

2. *Calcareous grit and shale*.—This formation succeeds immediately either the carboniferous limestone or the oolitic strata, and graduates at its lower extremity, where the conglomerate is wanting, into quartz-rock; but it is stated that at Glenlassera the position of the calcareous grit and the quartz-rock is unconformable to each other. Sectional lists are given, to show the order in which the grit and shale are associated; and from one of these lists it appears that beds of limestone are connected with them. The surface of the sandy strata in some of the quarries presents waved ripple-marks.

3. *Old red sandstone*.—This term is applied to the conglomerate

which occurs at the lower part of the north and south declivities of the Ox mountains. The pebbles consist of quartz and jasper: they are stated not to exceed an egg in size, and the imbedding cement is a stiff, ferruginous clay. No organic remains were observed. On the south side of the mountains, where the conglomerate rests upon quartz-rock, it is said to graduate into that formation; but on the north side, where the quartz-rock is wanting, the conglomerate rests unconformably on mica-slate.

4. *Quartz-rock*.—This formation occurs in many parts of the district, viz. on the south flank of the Ox mountains; in the Nephin and Birreen Cove mountains; at the headlands east and west of Broadhaven; on the south shore of Carramore lake; and on the south coast between Portarlin and Conoghrea. In its simplest state it consists of finely grained white quartz-sand, the beds having a schistose structure; but in some localities it contains white felspar and mica, when it graduates into gneiss.

5. *Hornblende-slate, mica-slate, and gneiss*.—No new details are given respecting the characters of these formations. Gneiss occurs principally in the peninsula of Erris, and in the mountains above Coolany, at Mullinashie; and the hornblende-slate and mica-slate in the Ox chain and the Erris group of mountains.

6. *Granite*.—This rock is found only at the southern extremity of Erris, and penetrates in veins the mica-slate which rests upon it.

7. *Trap*.—Under this head the author gives a detailed account of the composition, range, and effects of eleven parallel basaltic and amygdaloidal dykes, which traverse the northern part of the district in a nearly east and west direction, and cut through all the formations from gneiss to the carboniferous limestone. One of these dykes he traced between 60 and 70 miles, and was induced to conclude, from information which he received, that it might be followed much further to the eastward. The distance between the northern and southern dyke is only  $11\frac{1}{2}$  miles. Two of the dykes are said to be traversed by others having a north and south direction. A detailed account is also given of an extensive bed of trap, which overlies the mountain limestone and the sandstone and shale on the east and west sides of the Bay of Killala. Finally, the author offers a series of general observations on the origin of the different formations, and on the probable extension into England of the trap dykes of Mayo and Sligo.

A communication was then read from the Rev. Adam Sedgwick, V.P.G.S., and Woodwardian Professor in the University of Cambridge, respecting certain fossil shells overlying the London clay in the Isle of Sheppey.

Mr. Sedgwick, in examining a series of fossils from the Isle of Sheppey, lately presented to him, found several specimens differing from the rest, both in their specific characters and state of preservation. These shells were derived by Mr. Crow of Christ College, Cambridge, from a bed in Warder Cliff, about 15 feet below the surface of the ground, and had lately been laid bare by a small land-slip. The bed in question is from 8 to 12 inches thick, and

the part exposed is not more than 20 feet in length, though there can be little doubt that it extends considerably further. It rests almost immediately on the clays, containing the well-known suite of pyritous fossils with which the Isle so much abounds, and its level above the beach is stated to be about 140 feet. The specimens belong to the well-known English shells,—*Ostrea edulis*, *Cardium edule*, *Buccinum undatum*, *Fusus antiquus*, and *Turbo littoreus*.

Dec. 5.—The Rev. J. C. Stapleton, of Highclere, Hants, and Grosvenor-square, London; and John Forbes Royle, Esq., of the Bengal Medical Establishment, and lately Superintendent of the Hon. Company's Botanic Garden at Saharanpore, were elected Fellows of this Society.

A paper was read, entitled "Observations on the Remains of the Iguanodon, and other fossil Reptiles, of the Strata of Tilgate Forest in Sussex," by Gideon Mantell, Esq., F.G.S. R.S. and L.S.

The author, having noticed the various memoirs and works which have appeared on the organic remains of the fossil reptiles of Sussex, proceeded to give a summary account of all that was known upon the subject, and to add descriptions of the various interesting fossils which subsequent discoveries had brought to light. He observed that the strata of Sussex, with the exception of diluvial and tertiary deposits, were referrible to two series of formations only,—one, marine, including the chalk and green-sands; the other, fresh-water, the Wealden: the former, containing fishes, zoophytes, and marine shells; the latter, herbivorous saurians, turtles, terrestrial plants, and fresh-water shells. He then described the teeth and other bones of the Crocodile, *Megalosaurus*, *Plesiosaurus*, *Iguanodon*, and *Phytosaurus cylindricodon*. The head, jaws, and teeth of the last animal were stated to have been found in the Keuper of Germany, and the teeth in the Tilgate beds of Sussex. On the *Iguanodon* the author offered many new anatomical details: he particularly noticed,—an ungual bone, a clavicle of a most extraordinary form, and the thigh- and both leg-bones of the same limb, which exhibited enormous dimensions. He then gave a statement of the results of a careful comparison of six different portions of the skeleton of the recent Iguana and the *Iguanodon*, and stated that from this investigation it appeared the length of the animal was 70 feet, the tail forming about two thirds of the whole. A new fossil reptile was then described, of which a considerable portion of the skeleton of the trunk had been lately discovered. The block of stone in which the bones were imbedded was  $4\frac{1}{2}$  feet by  $2\frac{1}{2}$  feet. It exhibited a chain of 5 cervical and 5 dorsal vertebræ, with corresponding ribs; and four other vertebræ detached from the column and lying on other parts of the stone. The coracoids and omoplates of both sides were visible, and exhibited a structure so peculiar as to warrant the separation of this new reptile from all recent and fossil genera. With the coracoids of a Lizard, it had the omoplates of a Crocodile. A still more extraordinary peculiarity of osteological structure was exhibited in a series of spinous bony apophyses, which, varying in size from 3 to 17 inches in

length, and from  $1\frac{1}{2}$  to 7 in width at the base, maintained a certain parallelism with the vertebral column, as if they had been placed in a line along the back. This circumstance, together with other reasons, induced the author to suggest that they might be the remains of a dermal fringe, with which, as in some recent species of Iguana, the back of the animal was armed; but at the same time he mentioned many anatomical peculiarities, which led him to hesitate in determining positively that these bones had formed such appendages. He next entered upon a careful examination of the reasons why they could not be processes of the vertebræ. Many dermal bones, which served to support the large scales, were discovered by the author in the stone. The author proposed forming a new genus for this animal, the characters of which would depend on the peculiarity of the sternal apparatus and the spinous processes; and he suggested the name of Hylæosaurus, or Forest-Lizard, to indicate its locality, the Forest of Tilgate. In the conclusion of this memoir, the author made some observations on the character of the district at the Iguanodon era. From the condition of the organic remains, which, with the exception of the beds of shells, and the vegetable stems of the fossil *Equiseta Lyellii*, bore marks of transport, he contended that the river which had formed the ancient delta, the Wealden of geologists, must have had its source far distant from the beds which it had formed; and from the state of some of the specimens (and he instanced particularly that of the Hylæosaurus), he inferred, that the bones of the reptiles must have been broken and dislocated while covered with muscles and integuments, otherwise the broken parts and the displaced bones could not have maintained the relative situation in regard to each other which they are now found to maintain. He concluded with an eulogium on the late illustrious naturalist Baron Cuvier, many of whose observations, from his correspondence with the author, were introduced in various parts of the memoir.



PROCEEDINGS  
OF  
THE GEOLOGICAL SOCIETY OF LONDON.

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1832-1833.

No. 29.

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Dec. 19, 1832.—Richard Griffith Killaly, Esq., of Trinity College, Dublin, was elected a Fellow of this Society.

A paper was read, entitled "Report of a Survey of the Oolitic Formations of Gloucestershire." By William Lonsdale, F.G.S.

This survey was made in consequence of a resolution of the Council, confirmed by the Annual General Meeting of 1832, that one year's dividends of the Wollaston Fund should be applied to the continuing, northwards from Bath, the survey of the oolitic formations commenced by the author of the Report in the year 1827.

The district examined is bounded on the west by the escarpment of the oolitic hills from Toghill,  $4\frac{1}{2}$  miles N.W. of Bath, to Meon Hill, near Chipping Campden; and on the east by the foot of the coral-rag-hills, from the neighbourhood of Chippenham to Farringdon, and thence by a straight line passing from Burford to Stow-on-the-Wold and Shipston-on-Stour. The formations examined are the marlstone, inferior oolite, Fuller's earth, great oolite, forest marble, and cornbrash.

The geologists to whose labours the author acknowledges himself much indebted, are, Mr. Smith, Mr. Cumberland, Mr. Weaver, the Rev. William Conybeare, Mr. De la Beche, Mr. Murchison, and Mr. Greenough: he also notices the great advantage which he possessed in having the Ordnance Maps for the base of his survey.

*Marlstone*.—This formation was originally established by Mr. Smith, and its geological position, as a member of the lias formation, has been subsequently proved by Mr. Phillips, in his valuable work on Yorkshire. In Gloucestershire, the formation consists of about 150 feet of marl and sand, containing, towards the lower part, a bed of calcareous or ferruginous sandstone, abounding with organic remains; and its superior stratum consists of blue micaceous marl, the representative of the alum shale of Yorkshire. The most characteristic fossils are *Gryphæa gigantea* and *Pecten æquivalvis*. The marlstone is co-extensive with the escarpment, and may be traced within it wherever the beds subjacent to the inferior oolite have been denuded.

*Inferior oolite*.—In the South of Gloucestershire this formation consists of nearly equal divisions of soft oolite and slightly calcareous sand; but in the northern portion of the county, the latter, for the

greater part, is replaced by a yellow sandy limestone. The freestone beds, which are not to be lithologically distinguished from those of the great oolite, gradually increase in number and thickness, from the neighbourhood of Bath to the Cotteswolds, east of Cheltenham, where they constitute the whole of the escarpment. This vertical importance is retained through the north of the country examined; but to the eastward of the valley ranging from Stow-on-the-Wold to Barrington, near Burford, a change takes place, both in the structure and thickness of the formation. The freestone beds are there replaced by strata of nodular coarse oolite, containing numerous specimens of *Clypeus sinuatus*: the sandy portion consists of only a thin bed, and the thickness of the whole formation is diminished from 150 feet to about 50. The most characteristic fossils which were noticed by the author, are *Clypeus sinuatus*, *Terebratula fimbria*, *Modiola plicata*, *Pholadomya fidicula*, *Trigonia costata*, *Gryphæa columba* (Sowerby), *Lima proboscidea*, and *Ammonites corrugatus*.

The formation occupies, in Gloucestershire, a much greater superficial importance than has been hitherto assigned to it. Besides forming the upper part of the escarpment, it constitutes, to the south of Cheltenham, the inclined plane which ranges between the crest of the hills and the ridge of Fuller's earth and great oolite, and, to the north of that town, the summit of the whole of the hills, with the exception of an occasional capping of great oolite.

*Fuller's earth*.—This argillaceous deposit is of much less importance in the district surveyed than in the neighbourhood of Bath. The mineral to which it owes its designation is wanting, or is represented by only an occasional bed of impure, useless Fuller's earth. Its greatest thickness in Gloucestershire is estimated not to exceed fifty feet: in the Cotteswolds it was found to be not more than twenty-five; and the deposit was ascertained to thin out to the north-east of a line passing from the neighbourhood of Winchomb to Burford.

*Great oolite*.—The threefold arrangement of upper rags, fine freestone, and lower rags, into which this formation was divided near Bath, does not prevail through the whole of the district examined. The upper rags, consisting of soft freestone and hard shelly oolite, were traced to Cirencester; but to the north-east of that town they are replaced by a rubbly white argillaceous limestone. In the middle division, fine workable freestone is of partial occurrence; and the greater number of the beds are composed of hard oolitic limestone. The lower rags, consisting of coarse shelly oolites, resting upon closely-grained or crystalline limestone, extend from Bath to Wotton Underedge; but in the neighbourhood of that town a change occurs, and their position is occupied by beds of fissile calcareous limestone. These strata were traced through the whole of the north-east of Gloucestershire, and to the neighbourhood of Burford. They are extensively worked as a tile-stone; possess the lithological character of the Stonesfield slate; have their fissile property developed by exposure to atmospheric agency; contain *Trigonia impressa*, the characteristic fossil of Stonesfield; and, on comparing the strata of Burford with those which rest at Stonesfield on the slaty beds, it was found that



an almost perfect identity of character and order of position prevailed at the two localities\*.

The author, in alluding to the fossils of the great oolite, remarks on the important changes which are effected by removing the Stonesfield slate from the forest marble to the bottom of the great oolite.

*Forest marble.*—The Bradford clay, which separates the great oolite from the forest marble in Wiltshire, was observed only in the most southern part of Gloucestershire. Of the forest marble itself, the survey afforded no new characters. It was found to consist of a thick stratum of laminated shelly oolite, interposed between beds of sandy clay, containing laminæ of grit; and to have, from Bath to near Fairford, for its uppermost stratum, a deposit of loose sand, containing large masses of calcareous grit.

*Cornbrash.*—This formation consists, through nearly the whole of its range, of a thin deposit of rubbly, hard, compact limestone; but in the neighbourhood of Malmsbury it is composed of thick strata of crystalline limestone, alternating at their lower extremity with beds of sand, and surmounted by a stratum of sandy clay, containing laminæ of grit.

The author, in conclusion, notices four faults which affect all the strata from the lias to the forest marble: they occur at Stow-on-the-Wold; Clapton, near Bourton-on-the-Water; Brookhampton, near Cheltenham; and between Tetbury and Cirencester.

January 9, 1833.—Mr. Justice Bosanquet was elected a Fellow of this Society.

An Essay, entitled "Observations on Coal," by W. Hutton, Esq. F.G.S. was first read.

The author was led to the observations contained in this essay by pursuing the method of microscopic examination which has been so successfully employed by Mr. Witham. On examining, with the microscope, one of the thin slices of coal in which Mr. Witham lately discovered a distinct vegetable texture, the attention of the author was excited by the remarkable appearance of several cells in that part of the coal where the texture of the original plant could not be distinguished. Tempted to extend the inquiry, he procured an exten-

\* The following table contains Dr. Fitton's accurate enumeration of the beds of Stonesfield (see Zoological Journal, vol. iii.), and a list of those wrought at the Windrush quarries near Burford.

<i>Burford.</i>	<i>Stonesfield.</i>
Top. Rubbly limestone ..... 1 foot.	Top. Rubbly limestone.
Brownish marlstone ... 6 feet.	Clay.
Rubbly limestone ..... 4 feet.	Limestone.
Pale sandy marl..... 3 feet.	Blue clay.
Rubbly marlstone ..... $\frac{1}{2}$ foot.	Oolite.
Light-coloured clay ... $\frac{1}{2}$ foot.	Blue clay.
Rag and freestone ..... 15 feet.	Rag, oolitic limestone.
Sandy laminated grit.	Sandy bed, containing the slate.

The author states that he was indebted to Mr. Greenough for the first suggestion that the slate of Gloucestershire would prove to be the equivalent of the slate of Stonesfield.

sive series of slices, taken from the several varieties of coal found at Newcastle and the contiguous district.

The coal of the Newcastle district is considered by the author to be of three kinds. The first, which is the greatest in quantity and the best in quality, is the rich caking coal so generally esteemed; the second is Cannel or Parrot coal (Splent coal of the miners); and the third, the slate coal of Jameson, consists of the two former, arranged in thin alternate layers, and has, consequently, a slaty structure. In these varieties of coal, even in samples taken indiscriminately, more or less of the vegetable texture could always be discovered; thus affording the fullest evidence, if any such proof were wanting, of the vegetable origin of coal.

Each of these three kinds of coal, besides the fine distinct reticulation of the original vegetable texture, exhibits other cells, which are filled with a light wine-yellow-coloured matter, apparently of a bituminous nature, and which is so volatile as to be entirely expelled by heat before any change is effected in the other constituents of the coal. The number and appearance of these cells vary with each variety of coal. In caking coal, the cells are comparatively few, and those which do exist are highly elongated. Their original form the author believes to have been circular; and he attributes their present figure to the distention of gas confined in a somewhat yielding material, subject to perpendicular pressure. In the finest portions of this coal, where the crystalline structure, as indicated by the rhomboidal form of its fragments, is most developed, the cells are completely obliterated. In such parts the texture is uniform and compact: the crystalline arrangement indicates a more perfect union of the constituents, and a more entire destruction of the original texture of the plant.

The slate-coal, or the third variety above mentioned, contains two kinds of cells, both of which are filled with yellow bituminous matter. One kind is that already noticed in caking coal; while the other kind of cells constitutes groups of smaller cells of an elongated circular figure.

In those varieties which go under the name of Cannel, Parrot, and Splent Coal, the crystalline structure, so conspicuous in fine caking coal, is wholly wanting, the first kind of cells are rarely seen, and the whole surface displays an almost uniform series of the second class of cells, filled with bituminous matter, and separated from each other by thin fibrous divisions.

After describing these appearances, and illustrating them by drawings, the author proceeds to speculate on the origin of the cells in Cannel coal. He considers it highly probable that they are derived from the reticular texture of the parent plant, rounded and confused by the enormous pressure to which the vegetable matter has been subject.

The author next states, that though the crystalline and uncrystalline, or, in other terms, perfectly and imperfectly developed, varieties of coal generally occur in distinct strata, yet it is easy to find specimens which in the compass of a single square inch contain both va-

ieties. From this fact, as also from the exact similarity of position which they occupy in the mine, the differences in different varieties of coal are ascribed to original difference in the plants from which they were derived.

The author next adverts to the escape of inflammable gas from coal, and cites various interesting facts, principally from the authority of Sir H. Davy and Mr. Buddle, in proof of the existence of inflammable gas ready formed in coal while contained in the mine ; of the immense quantity which is sometimes emitted by blowers, indicating a free communication between the reservoirs in which it resides ; and of the great pressure to which it is there subject. He ingeniously shows the probability of the gas existing within the coal in so compressed a state as to be liquid. A consideration of these circumstances induced the author, while engaged in his microscopic inquiries, to search for a structure in coal capable of containing gas ; and he accordingly discovered a system of cells, different from any before mentioned, and apparently adapted for that purpose. These supposed gas cells are found empty, are generally of a circular form, occur in groups which communicate with each other, and each cavity has in its centre a small pellet of carbonaceous matter. The author establishes a clear distinction between these gas cells and those above described as being filled with bituminous matter ; for the anthracite of South Wales contains the former, but is quite free from the latter. He also states, on the authority of Mr. F. Foster, that the anthracite of South Wales affords a free disengagement of inflammable gas when first exposed to the air.

A communication "On *Ophiura* found at Child's Hill, to the N.W. of Hampstead," by Nathaniel Thomas Wetherell, Esq. F.G.S. was then read.

After noticing the rare occurrence of *Ophiura*, and that in England they had hitherto been observed only in the chalk and the lower division of the oolitic series, the author states, that he discovered, in 1829, several specimens of a species of *Ophiura* in the septaria of the London clay of Child's Hill ; that they were associated with some of the most characteristic shells of that formation ; and that he had found fragments of the same *Ophiura* in a septarium from the Highgate Archway.

Jan. 23.—Herman Merivale, Esq. of Woburn Place, Russell Square ; the Rev. Robert Hankinson, of Bilney Lodge, Lynn ; and Charles Atticus Monck, Esq. of the Coldstream Guards ; were elected Fellows of this Society.

A Geological Memoir was read "On a portion of Dukhun, East Indies," by Lieut.-Col. W. H. Sykes, F.G.S. F.L.S. &c.

The author describes his track as bounded on the west by the range of mountains usually called the Ghauts by Europeans, from a misconception of the term Ghaut, which simply means a pass, the proper name being the Syhadree ; on the north by the Mool river, on the east by the Seena river ; on the south by a line drawn from the city of Beejapoor to the town of Meeruj, continued up the Krishna and Quina rivers to the hill fort of Wassota in the Ghauts ; comprising

an area of about 26,000 square miles, and lying between the parallels of north latitude  $16^{\circ} 45'$  and  $19^{\circ} 27'$ , and east longitude  $73^{\circ} 30'$  and  $75^{\circ} 53'$ .

The whole of this tract, whether at the level of the sea or at the elevation of 4500 feet, is composed of distinctly stratified, horizontal, alternating beds of basalt and amygdaloids, without the intervention of the rocks of any other formation. Similar stratification and structure is instanced in Malwa, and in the Vindhya, Gawelghur, and Chandore ranges of mountains.

The Dukhun (the mean elevation of the valleys and table-land of which is about 1800 feet above the sea) is described as rising very abruptly by terraces from the country at its base : to the eastward it declines by terraces ; but these being low, and occurring at long intervals, excite little remark. On the top of the Ghauts there are numerous spurs or ranges of mountains extending to the E. and S.E. The valleys between them are either narrow, tortuous and fissure-like, or wide and flat ; both ends being of nearly equal width. A river runs through each valley, having its source at the western end. The author does not think it physically possible for the present rivers to have excavated any of these valleys. Those of a fissure-like character might be referred to a period when the country was heaved up from below the sea, if such ever took place ; but this explanation would not account for the broad flat valleys margined by scarped mountains.

The author notices successively the extensive occurrence of columnar basalt, and instances numerous localities of basaltic pavements of pentangular slabs ; being, in fact, the terminal planes of basaltic columns. He also notices singular insulated heaps of rocks and stones, the loose parts of which manifest a disposition to geometrical forms. He witnessed repeated occurrences of nodular basalt, or *basalt en boules* ; of stupendous escarpments ; of dykes of great length, in some instances crossing each other ; of strata of ferruginous clay under compact basalt, which, in different localities, pass from friable to jaspery ; the occurrence of pulverulent lime in seams ; and minute nodular limestone on the surface and in the banks of rivers. Crystallized lime was noticed as an imbedded mineral only. He observed numerous veins of quartz and chalcodony traversing the basaltic strata, and supplying the major part of the siliceous minerals abundantly strewn over the country, such as, agates, jaspers, hornstones, heliotrope, semiopal, stilbite, heulandite, mesotype, ichthyophthalmite, pseudomorphous quartz, &c. &c. ; and he mentions the occurrence of muriate and carbonate of soda, of the ores of iron which are worked into the celebrated wootz steel, and of thermal springs. The author did not observe any conformation of the mountains resembling the craters of extinct volcanoes, nor did he find organic remains of any kind.

The paper concludes with some general observations (limiting their application to the 25th degree of north latitude) on the amazing extent of the trap, laterite, nodular limestone, granite and gneiss formations in the peninsula of India. From the geological papers of Capt. Dan-

gerfeld, Capt. Coulthard, Major Franklin, Dr. Voysey, and Mr. Calder, the continuous trap region would appear to occupy an area of from 200,000 to 250,000 square miles; and from the observations of the Rev. Mr. Everest, Mr. Royle, Mr. Babington, Mr. Calder, and Dr. Voysey, it may ultimately be found that the ramifications extend eastward to the Rajmahl trap-hills on the Ganges, and southward through Mysore to the extremity of the peninsula. With respect to the age of this formation, Major Franklin states, that in Bundelkhund it rests on a sandstone which he considers identical with the new red sandstone of Europe: the trap would therefore be posterior to the carboniferous series, and belong to the supermedial order. But the Rev. Mr. Everest adduces valid reasons for questioning the correctness of Major Franklin's opinion, and it would consequently be idle to speculate on an era without sufficient data to assist in determining the question. The author suggests the manner of the formation of the horizontal beds of basalt and amygdaloids, with their *parallel, superior, and inferior planes* and *vertical edges*, as a subject of curious and interesting speculation.

From the observations of Mr. Calder, the Rev. Mr. Everest, Mr. Stirling, Dr. Davy, and the author, the laterite formation is found to extend for several hundred miles, with few interruptions, along both shores of the peninsula, and into Ceylon. Ample evidence is given of the occurrence of nodular and pulverulent lime all over Dukhun and Hindoostan. With respect to granite and gneiss, Dr. Voysey collected facts which led him to believe that these rocks constituted the basis of the whole peninsula, and, on this belief, must occupy an area, roughly calculated, of about 700,000 square miles.

The author is not aware of the occurrence of sedimentary rocks in Western India south of Baroach, excepting such as may have resulted from the consolidation of comparatively recent alluvium.

Finally, the author considers the characteristic geological features of the peninsula to consist in the amazing extent of the trap, and the horizontal position of its stratified beds; in the granitic basis of the whole country; in the existence of trap veins in granite; the absence, as far as is at present known, of that uniform series of rocks constituting the formations of Europe; in the extended and peculiar nodular limestone and laterite formations; the occurrence of pulverulent lime in seams; and in the non-discovery hitherto of the fossil remains of extinct animals.

The memoir was accompanied by a coloured map, two sections of the country, several sketches of its physical features, and numerous rock and mineral specimens.

A letter was afterwards read, addressed to the Rev. Prof. Buckland, D.D. V.P.G.S. by Joshua Trimmer, Esq. F.G.S., respecting the discovery of marine shells of existing species on the left bank of the river Mersey, and above the level of high-water mark.

Mr. Trimmer, in a recent visit to Runcorn, discovered, in a low tract of country on the bank of the Mersey, a section about twenty feet thick, which presented the following series of beds:—

Top—1. Yellow coarse sand, containing a few pebbles, but no shells, three to six feet.

2. A layer of decayed vegetable matter, varying in thickness from half an inch to three inches.

3. A bed fourteen feet thick to high-water mark, composed, in the upper part, chiefly of sand, and in the lower of clay. It contains a few fragments of the new red sandstone of the adjacent district, and numerous erratic pebbles of granite, syenite, greenstone, limestone, grauwacke, quartz-rock and sandstone. These pebbles vary in size from half an inch to six inches in diameter: associated with them are a few blocks, some of which are estimated to weigh a quarter of a ton each. It is in this bed, but particularly in the lower part, that the author found the marine remains, which he describes as belonging to the genera *Cardium*, *Turritella*, and *Buccinum*; but he observes, that they occur only as fragments, agreeing, in their state of preservation, with those which he discovered on a former occasion at Moel Tryfan, on the flank of Snowdon.

These data the author considers afford proofs of three distinct operations:

1st, An irruption of the sea bringing with it fragments of sea-shells and of rocks not existing *in situ* in the neighbourhood.

2ndly, The deposition of the layer of peat. And

3rdly, The accumulation of the bed of sand forming the upper portion of the section.

The author, in pursuing his inquiries, found, on the top of the sandstone quarries at Weston, near the locality above described, and at a height exceeding 100 feet above the level of high-water mark, a bed of sandy loam, containing similar erratic pebbles; but he was not able to discover in it any marine remains.

Feb. 6.—John Taylor, jun. Esq., of Coed-ddú, Flintshire; Richard Taylor, Esq., of Perran, Arworthal; Richard Davey, Esq., of Redruth, Cornwall; Henry Enfield, Esq., of Raymond Buildings, Gray's Inn; and P. J. Martin, Esq., of Pulborough; were elected Fellows of this Society.

A paper was read, entitled “Notes to accompany a Map of the Forest of Dean and the Country adjacent, coloured geologically,” by Henry Maclauchlan, Esq. F.G.S., employed in the Ordnance Survey.

The author commences his memoir by acknowledging the aid which he received from his colleagues employed in the Ordnance Survey, Messrs. J. and R. Wright and Mr. Carrington; and the valuable assistance afforded him by the Rev. W. D. Conybeare, Dr. Buckland, Mr. De la Beche, Mr. Mushet, Mr. H. James, Mr. Bathurst, Mr. Ormerod, Mr. M. Teague, Mr. Bennett, and Mr. Hale.

The district coloured by the author comprises an area of about 1000 square miles. Its western boundary is defined by a line passing from Gold Cliff, near Newport, to Preston on the Wye, eight miles N.W. of Hereford; and its eastern by another ranging from Didmarton to Stroud, Gloucester, and Hanley Castle, four miles E. of Malvern.

The author first describes the band of transition limestone which

extends, with little interruption, from Shucknell Hill, four miles and a half N.E. of Hereford, to Flaxley, near Westbury-on-Severn. He shows that the formation consists of beds of limestone and shale, resting at May Hill on a central ridge of greywacke, and along its western boundary underlying the old red sandstone; but that along its eastern, it is overlaid by that formation, the Newent coal-field, and the new red sandstone. He also states that great irregularity occurs in the dip of the beds.

*Old red sandstone.*—This formation is shown to occupy a very great part of southern Herefordshire and the district bordering on the Forest of Dean. It is stated to consist of beds of sandstone, conglomerate, nodular limestone, and clay; the limestone occurring in the lower part of the formation, and the conglomerate principally in the middle.

The next deposit described is the carboniferous limestone. It is shown to surround the coal-field of the Forest of Dean, with the exception of a district near the south-eastern extremity of the basin, where it is cut off by a fault. The lower beds are said to be of a crystalline texture, and separated from the upper or argillaceous and sandy beds by a stratum of iron ore. From the southern extremity of the coal-field, the limestone extends in a south-west direction by Chepstow and Caerwent to Magor.

*Coal-measures.*—The author then enters into a minute detail of the beds composing the coal-field of the Forest of Dean. They are stated to be divisible into two series; the lower characterized by the seams of coal being separated from each other by strata of coarse sandstone; and the upper, by the seams of coal being separated by strata of argillaceous shale. The field, it is said, rests upon the mountain limestone. The author next describes the Newent coal-basin, and shows that it differs in geological position from that of the Forest of Dean, by resting along its western and southern edges upon the transition strata, and along its north-western upon the old red sandstone; and that it is overlaid at its eastern boundary by a conglomerate belonging to the new red sandstone. Two outliers of the Forest of Dean coal-field are also alluded to, and shown to occur at Howl Hill and Tidenham Chase.

*New red sandstone.*—In describing this deposit, the author acknowledges the great difficulty he experienced in endeavouring to separate it from the old red sandstone, when in contact with that formation. He states, that the only characters on which he could rely, were the absence of beds of conglomerate, of flagstone and of gray clay containing nodules of cornstone; the presence, near Tidenham, of the conglomerate belonging to the magnesian limestone; and the occasionally well-defined unconformity in the dip of the strata in the older and newer deposits.

The author then shows that extensive beds of superficial gravel occur in the neighbourhood of Hereford, and along the valley of the Wye as far as Ross. The boundaries of these accumulations are accurately defined upon the map; and he is of opinion, that the

drainage of the country around Hereford was effected by the opening of the valley of the Wye.

*Faults.*—In conclusion, the author gives a detailed account of the fault which occurs near the S. E. extremity of the coal-field of the Forest of Dean : and in the course of the memoir, allusion is also made to the fault which has disturbed the coal-measures at Lidbrook valley.



PROCEEDINGS  
OF  
THE GEOLOGICAL SOCIETY OF LONDON.

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1833.

No. 30.

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AT THE  
*ANNUAL GENERAL MEETING,*

*15th February 1833,*

The following Report from the Council was read :—

It is gratifying to the Council that they are able to give a most satisfactory Report of the affairs of the Society. Ample donations of Books and Specimens have been received since the last Anniversary, whereby the value and usefulness of the Library and Museum are materially increased. The large accession of new Members since the last annual Report, amounting to 44, affords a gratifying proof of the unabated interest which is taken in this Society, and of the growing taste for geological pursuits. The state of the funds is equally satisfactory ; since, after paying all debts, there remains a balance in hand of nearly 900*l*.

The Second Part of the Third Volume of the Transactions, announced as ready for publication at the last Anniversary, has since been published ; and the Supplement to that volume, together with the First Part of the Fourth Volume, is preparing for publication.

In pursuance of the Resolution of a Council held on the 18th of January 1832, one year's dividend of the Wollaston Fund has been paid to Mr. Lonsdale, for continuing during the then ensuing summer a survey of the oolitic series of England northwards from the neighbourhood of Calne ; and the Council cannot suffer this opportunity to pass, without expressing their entire approbation of the masterly manner in which the work has been done and recorded in the Memoir read before this Society.

The annexed Reports comprehend a full statement of the affairs of the Society.

**REPORT** of the Committee appointed to examine and report on the state of the Museums.

In consequence of the absence of the Curator in fulfilment of the Resolution of the Council of the 18th January 1832, directing that one year's dividend of the Wollaston Fund should be paid to Mr. Lonsdale, for continuing, during the summer then ensuing, a survey of the oolitic series of England northwards from the neighbourhood of Calne, the Committee are not able to report any progress in the arrange-

ment of the collections. The greater part of last summer was necessarily spent by the Curator in the field, and the fruits of his industry and perspicuity are too well known to the Society, through the medium of his admirable Memoir, to require any further observation on this head.

The principal Donations which the Committee are called upon to notice are the extensive suite of specimens from the formations on the border counties of England and Wales, collected during the last vacation by Mr. Murchison, who has also presented the skeleton of a Dugong, specimens of *Draco volans*, and other Saurians.

The Rev. T. T. Lewes, Mr. Proctor, and Mr. Jones have enriched the English collection by extensive series of fossils from the Transition-beds of Herefordshire.

To Francis Chantrey, Esq. the Society are indebted for a cast of the noble specimen of *Plesiosaurus Dolichodeirus* in the collection of the Duke of Buckingham; to Viscount Cole for a cast of his fine *Plesiosaurus Macrocephalus*; and to Mr. Thomas Hawkins for a cast of his small, but beautifully perfect *Plesiosaurus Dolichodeirus*.

The value of the Irish collection has been considerably augmented by donations collected in the county of Fermanagh, by Viscount Cole and Sir Philip Egerton, and presented by them to the Society.

The Honourable Board of Directors of the East India Company have contributed specimens of recent Palms and Cycadeæ; and the Asiatic Society of Calcutta have presented many cases of collections from various parts of India.

The Committee have the pleasure of reporting that the Library has received, during the past year, many important additions, upwards of one hundred volumes and pamphlets having been added to the catalogue,—and recommend that additional book-shelves be provided, the number at present fixed not being sufficient for the works in the Society's possession.

The rapid increase of the collections demands equivalent depositories; and the Committee recommend that one set of cabinets be added to those in the Foreign Museum, and two sets to those in the English Museum, and that these additions should correspond with the cabinets already in use in each department.

WM. HENRY FITTON, V.P.  
W. SOMERVILLE.  
W. J. BRODERIP.

*Geological Society's Apartments,*  
Feb. 6th, 1833.

Comparative Statement of the number of the Society, at the close of the years 1831—1832.

FEBRUARY 15th, 1833.

Fellows.	31st Dec. 1831.	31st Dec. 1832.
Having compounded.....	64.....	70
Contributing . . . . .	187.....	210
Non-residents . . . . .	288.....	306
	<hr/>	<hr/>
	539	586
Honorary . . . . .	50.....	48
Foreign Members . . . . .	58.....	57
Personages of Royal Blood . . . . .	3.....	3
	<hr/>	<hr/>
	650	694

*The following Persons were elected Fellows of this Society during the Year 1832.*

- January 18th.—Nathaniel T. Wetherell, Esq. of Highgate, Middlesex; Capt. T. E. Sampson, 22nd Regiment of the Bengal Native Infantry; and the Hon. and Very Reverend the Dean of Windsor.
- February 29th.—The Earl of Kerry, of Lansdowne House; and William Smith, Esq. of Blandford-square.
- March 14th.—William Ogilby, Esq. of York-street, Portman-square; Francis Boott, M.D. of Gower-street; James Bowerbank, Esq. of Sun-street, Bishopsgate-street; Lieut.-Col. Sykes, of the Bombay Establishment; Peter Stafford Carey, Esq. of St. John's College, Oxford; and John Fisher, Esq. of Highbury Park, Middlesex.
- March 28th.—Col. the Earl of Munster, of Belgrave-street; Robert Daun, M.D. of Brompton-square; J. Robinson Wright, Esq. and Henry Maclauchlan, Esq. of the Trigonometrical Survey; the Hon. William Charles W. Fitzwilliam, of Trinity College, Cambridge; Joshua Trimmer, Esq. of Bangor; Rev. Frederick W. Hope, of Christchurch, Oxford; John Cotterell Powell, Esq. of Jesus College, Cambridge, and Upper Harley-street, London; Robert Hunter, Esq. of Burton Crescent; Mr. Sergeant Taddy, of Sergeant's Inn, Chancery-lane; Thomas Bodley, Esq. of Brighton; and Capt. Alexander Robe, R.E. of Park Road, Regent's Park.
- April 11th.—Peter Frederick Robinson, Esq. of Lower Brook-street; and the name of John Buddle, Esq. was removed by ballot from the Honorary to the Ordinary List of Fellows.
- May 2nd.—Thomas Baker, Esq. of Wilton-place; and Capt. Jones, R.N. M.P. of Curzon-street.
- May 16th.—James Mitchell, Esq. of New Broad-street.
- June 13th.—William Henry Egerton, Esq. of Oulton Park, Cheshire; Bridgeman Moore, Esq. of Lindley Hall, Shropshire; George Mercer, Esq. of Queen Ann-street, West; Thomas Hawkins, Esq.

of Street, near Glastonbury ; Thomas Watson, M.D. late Fellow of St. John's College, Cambridge ; Lieut.-Col. Hugh Montgomery ; and Edward Hussey, Esq. of Park-street, Grosvenor-square.

November 7th.—Woodbine Parish, jun. Esq. of Upper Harley-street, His Majesty's Consul-General at Buenos Ayres ; Henry Trollope, Esq. of Harrow ; Whitlock Nichol, M.D. of Curzon-street ; and Herbert Mayo, Esq. Professor of Anatomy in King's College, London.

Nov. 21st.—J. F. Ellis, Esq. of Dover-street ; G. Wilbraham, Esq. M.P. of Upper Seymour-street ; George Bentham, Esq. of Gloucester-street, Portman-square, and S. Jedediah Tucker, Esq. of Trematon Castle, Cornwall.

December 5th.—J. F. Royle, Esq. of the Bengal Medical Establishment ; Rev. J. C. Stapleton, of Grosvenor-square ; and Robert Hudson, Esq. of Clapham Common.

December 19th.—Richard G. Killaly, Esq. of Trinity College, Dublin.

The Names of the Fellows and Foreign and Honorary Members deceased, within the past year, are as follows :—

Compounders, (None.)—Residents, (None.)—Non-resident, Samuel Galton, Esq.—Foreign, Baron Cuvier.—Honorary, Rev. Benjamin Richardson.

The MUSEUM has received many Donations since the last Anniversary, among which are included the following :—

*British and Irish Specimens.*

Corals from the Mountain Limestone of Ireland ; a slab of Fossil Wood, from Sheppey ; casts of the *Plesiosaurus Macrocephalus*, and of a Tooth of the gigantic Tapir ; also a specimen of crystallized Magnesian Carbonate of Lime ; presented by Viscount Cole, M.P. F.G.S.

Minerals from Devonshire and Cornwall ; and specimens of Syenite from Charnwood Forest ; presented by T. H. Holdsworth, Esq. F.G.S.

Tusk of a Mammoth, found in the gravel near Nine Elms, Surrey ; presented by Charles Larkin Francis, Esq. F.G.S.

Chalk Flints, from Hemel Hempstead ; presented by H. C. White, Esq. F.G.S.

Cast of the Head of a Crocodile, found in the London Clay, Sheppey ; presented by Edward Spencer, Esq. F.G.S.

An Agate from the Trap of Edinburgh ; and Fossils from the neighbourhood of Bath ; presented by Ashurst Majendie, Esq. F.G.S.

Chalk Flints from the neighbourhood of Salisbury ; presented by the Rev. C. Watkins.

Casts of two Toe-bones from Cuckfield ; presented by Robert Trotter, Esq. F.G.S.

Specimens from the neighbourhood of Cheltenham ; and from the fossiliferous Grauwacke on the borders of Wales and England ; also a specimen of Murchisonite ; presented by Roderick Impey Murchison, Esq. P.G.S.

- Fossils from the Oolite of Buckinghamshire and Oxfordshire ; and a portion of the Fossil Tree found at Craighleith Quarry ; presented by Henry Maclauchlan, Esq. F.G.S.
- Specimens of Sulphate of Strontia, and of Hæmatite, from the neighbourhood of Bristol ; presented by Frederick Page, Esq. F.G.S.
- A collection of Fossils found at Highgate ; and specimens of Ophiura from the London Clay, near Hampstead ; presented by Nathaniel Thomas Wetherell, Esq. F.G.S.
- Specimens of Semiopal from Dartmoor, and of Granite Veins from Devonshire and Cornwall ; presented by J. H. Deacon, Esq. F.G.S.
- Fossil Testacea from the Lias of Rugby ; presented by George Fox, Esq. F.G.S.
- Cast of the Remains of Fossil Fishes from the Coal Measures, near Leeds ; presented by the Council of the Leeds Philosophical Society.
- A Specimen of Dudley Limestone ; presented by John Bostock, M.D. F.G.S.
- Cast of the Duke of Buckingham's *Plesiosaurus dolicodeirus* ; presented by Francis Chantrey, Esq. F.G.S.
- Casts of Asterias from the Chalk ; presented by S. Woodward, Esq.
- A Specimen of Fresh-water Sponge, and Fossils from the Chalk ; presented by the Rev. Henry Engleheart, F.G.S.
- Fossils from the Weald Clay and Hastings Sand ; presented by Gideon Mantell, Esq. F.G.S.
- Recent Shells from the Coast of Devonshire ; presented by Mrs. Lane.
- Tusk of an Elephant found at Erith, in Kent ; presented by Messrs. Munn, Elston, and Clarke.
- A Bone from the Peat at Woolhampton, between Reading and Newbury ; presented by Robert Hunter, Esq. F.G.S.
- Specimens of Forest Marble from the neighbourhood of Castlecombe ; presented by Poulett Scrope, Esq. F.G.S.
- Quartz Crystals from Monmouthshire ; presented by Mrs. Taddy and Miss Morris.
- A Specimen of Chalcedonic Flint from Ridgeway, near Weymouth, and recent Corals and Serpulæ ; presented by Miss Warne.
- Specimens of Ludlow Rock ; presented by Mr. Jones.
- Specimens of Ludlow Rock ; presented by — Proctor, Esq.
- Fossils from the Transition Limestone of Herefordshire ; presented by the Rev. T. T. Lewis, A.M.
- Cast of a Fossil Plant from the Coal Measures ; presented by Lewis Gower, Esq.
- Specimen of Fossil Wood from the Lower Green-sand, Aspley Wood, near Woburn ; presented by E. Crocker, Esq.

*Foreign Specimens.*

- Fossil Fish from Mansfield ; presented by R. G. Killaly, Esq. F.G.S.
- The Skeleton of a Dugong, and Specimens of *Draco volans*, and other Saurians ; presented by Roderick Impey Murchison, Esq. P.G.S.
- A Specimen of the Volcanic Island thrown up in the Mediterranean in 1831 ; presented by Baron Field, Esq.
- A Specimen of Leucite from Vesuvius ; presented by J. Kenyon, Esq.

- A Specimen of Leucitic Lava from Civita Castellana ; presented by Ashurst Majendie, Esq. F.G.S.
- Minerals and Fossils from North America ; presented by Dr. Macauley.
- Indian Palms and Cycadeæ ; presented by the Honourable Directors of the East India Company.
- Specimens from the neighbourhood of Lisbon and Oporto ; presented by Daniel Sharpe, Esq. F.G.S.
- Casts of *Scaphites Cuvieri* from the marl of Delaware, and of a Tooth of a Mosasaurus from the marl of North Jersey ; presented by Dr. Morton.
- Fossils from the Transition Formations on the Banks of the Rhine ; presented by John Willimott, Esq. F.G.S.
- Specimens from Italy ; presented by Alexander Logan, Esq. F.G.S.
- Specimens from Peten in Mexico ; presented by Lieut. Col. Galindo.
- Specimens from the Gold Mines of North Carolina ; presented by John Taylor, Esq. Treas. G.S.
- Specimens from Ceylon ; presented by Dr. Sibbald.
- Specimens from the neighbourhood of Swan River ; presented by Capt. Mangles, R.N.
- Silver and other Ores from the provinces of La Plata and Potosi ; also specimens of opalized Wood and Pebbles from the Uruguay, and of the Acatama Iron ; presented by Woodbine Parish, jun. Esq. F.G.S.
- Specimens collected by Capt. Coulthard in Bundelcund ; presented by the Asiatic Society of Calcutta.
- Specimens illustrative of the Trap districts of the Deccan ; presented by Lieut.-Col. Sykes, F.G.S.

The LIBRARY has been increased by the Donation of above one hundred volumes and pamphlets.

The First Part of the Fourth Volume of the New Series of the Transactions has been put to press, and it is hoped that it will be published during the ensuing summer.

The following LIST contains the NAMES of all the Persons and Societies from whom Donations to the Library and Museums have been received during the past year.

Academy of Science of Palermo.	Boubée, M. Nérée.
Adam, Walter, M.D.	Brewster, Sir David, F.G.S.
Alger, F. Esq.	Bristol Institution.
American Philosophical Society,	British Association.
Philadelphia.	Broderip, W. J. Esq. F.G.S.
Anti-Slavery Society.	Brongniart, M. Alex., For. Mem.
Asiatic Society of Calcutta.	G.S.
Auldjo, John, Esq. F.G.S.	Brooke, Henry, Esq. F.G.S.
	Buch, M. Leopold de, For. Mem.
	G.S.
Babbage, Charles, Esq.	Buckland, Rev. William, D.D.
Bischoff, James, Esq.	V.P.G.S.
Black, Young, and Young.	Burton, Decimus, Esq. F.G.S.
Bostock, John, M.D. F.G.S.	

Cacciatore, Nicholao.  
 Cambridge Philosophical Society.  
 Chantrey, Francis, Esq. F.G.S.  
 Clerget, M.  
 Cole, Viscount, M.P. F.G.S.  
 College of Surgeons.  
 Committee of the Athenæum  
 Club.  
 Committee of the Oriental Trans-  
 lation Fund.  
 Conrad, T. Esq.  
 Coxe, Leonard T. Esq. F.G.S.  
 Crocker, E. Esq.  
 Daubeny, Charles, M.D. F.G.S.  
 Deacon, James H. Esq. F.G.S.  
 De la Beche, Henry T. Esq. F.G.S.  
 Desnoyers, M. Jules.  
 Donati, M.  
 East India Company.  
 Editor of the Athenæum.  
 Engleheart, Rev. Henry, F.G.S.  
 Faraday, Michael, Esq. F.G.S.  
 Featherstonhaugh, George W.  
 Esq. F.G.S.  
 Field, Baron, Esq.  
 Fitton, William Henry, M.D.  
 V.P.G.S.  
 Fox, G. T. Esq. F.G.S.  
 Francis, Chas. L. Esq. F.G.S.  
 Gairdner, Meredith, M.D.  
 Galindo, Lieut. Col.  
 Geological Society of Dublin.  
 Geological Society of France.  
 Goodhall, Henry H. Esq. F.G.S.  
 Gordon, Alexander, Esq.  
 Gower, Lewis, Esq.  
 Greenough, G. B. Esq. F.G.S.  
 Hall, Mr. Elias.  
 Harlan, R. M.D.  
 Harrison, Mr. J.  
 Hausmann, M. John F. L. For.  
 Mem. G.S.  
 Herschel, Sir John F. F.G.S.  
 Hibbert, Samuel, M.D. F.G.S.  
 Holdsworth, T. H. Esq. F.G.S.

Humboldt, Baron Alex. For  
 Mem. G.S.  
 Hunter, Robert, Esq. F.G.S.  
 Hutton, William, Esq. F.G.S.  
 Jackson, C. T. Esq.  
 Jones, Mr.  
 Kent, Samuel Luck, Esq. F.G.S.  
 Kenyon, John, Esq.  
 Killaly, R. G. Esq. F.G.S.  
 Lane, Mrs. "  
 Lea, Isaac, Esq.  
 Leeds Philosophical Society.  
 Lewis, Rev. T. T.  
 Lindley, John, Esq. F.G.S.  
 Logan, Alexander, Esq. F.G.S.  
 Loudon, John C. Esq. F.G.S.  
 Lyell, Charles, For. Sec. G.S.  
 Macauley, —, M.D.  
 Maclauchlan, Henry, Esq. F.G.S.  
 Majendie, Ashurst, Esq. F.G.S.  
 Mangles, Capt. R. N.  
 Mantell, Gideon, Esq. F.G.S.  
 Master General and Board of  
 Ordnance.  
 Meyer, Hermann von.  
 Morris, Miss.  
 Morton, S. G. M.D.  
 Mudie, Robert, Esq.  
 Munn, Elston, and Clarke.  
 Murchison, Rod. Imp. Esq. P.G.S.  
 Natural Hist. Soc. of Geneva.  
 Necker, M. L. A. For. Mem. G.S.  
 Northampton, Marquis of, F.G.S.  
 Page, Frederick, Esq. F.G.S.  
 Parish, Woodbine, jun. Esq.  
 F.G.S.  
 Paxton, Mr. Joseph.  
 Pettiward, Rev. Daniel, F.G.S.  
 Phillips, Richard, Esq. F.G.S.  
 Prevost, M. C. For. Mem. G.S.  
 Proctor, —, Esq.  
 Royal Academy of Science of  
 France.

Royal Asiatic Society of Great Britain and Ireland.	Turner, Edward, M.D. Sec. G.S.
Royal Geographical Society of London.	Vandermaclen, M.
Royal Leopold Society of Bonn.	Wallich, N. M.D. F.G.S.
Royal Society of Edinburgh.	Warne, Miss.
Royal Society of Literature.	Watkins, Rev. C.
Royal Society of London.	Weatherhead, George, M.D.
	Weiss, Professor, For. Mem. G.S.
Scharfe, Mr. G.	Wetherell, Nathaniel Thomas, Esq. F.G.S.
Scrope, G. P. Esq. F.G.S.	Whewell, Rev. William, F.G.S.
Sharpe, Daniel, Esq. F.G.S.	White, Henry C. Esq. F.G.S.
Sibbald, —, M.D.	Willimott, John, Esq. F.G.S.
Silliman, Benjamin, M.D. For. Mem. G.S.	Wilson, H. H. Esq.
Smythe, Capt. R.N.	Witham, Henry, Esq. F.G.S.
Society of Arts and Sciences.	Wood, William, Esq. F.G.S.
Spencer, Edward, Esq. F.G.S.	Woodward, Samuel, Esq.
Sykes, Lieut. Col. F.G.S.	Wright, J. R. Esq.
	Yorkshire Philosophical Society.
Taddy, Mrs.	Zoological Society of London.
Taylor, John, Esq. Treas. G.S.	
Taylor, Richard, Esq. F.G.S.	
Trotter, Edward, Esq. F.G.S.	

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*List of PAPERS read since the last Annual Meeting, Feb. 17th, 1832.*

March 14.—On the Structure of the Cotteswold Hills and Country around Cheltenham; and on the occurrence of stems of Fossil Plants, in vertical positions, in the Sandstone of the Inferior Oolite of the Cleveland Hills; by Roderick Impey Murchison, Esq. P.G.S. F.R.S.

March 28.—A Sketch of the Geology of Pulo Pinang and the neighbouring Islands; by J. W. Ward, M.D. Assistant Surgeon of the Madras Establishment, and communicated by the President.

——— An Attempt to bring under general Geological Laws the relative Position of Metalliferous Deposits, with regard to the Rock Formations of which the Crust of the Earth is formed; by M. Albert Louis Necker, For. Mem. G.S.

April 11.—A Letter from George Gordon, Esq. addressed to Roderick Impey Murchison, Esq. P.G.S. noticing the existence of Lias on the southern side of the Murray Firth.

——— On the Strata of the immediate neighbourhood of Lisbon and Oporto; by Daniel Sharpe, Esq. F.G.S.

——— An Essay on the Curvilinear Structure of Lava; by Signor Monticelli, For. Mem. G.S.

May 2.—On the Geological Structure of the North-eastern part of the County of Antrim; by James Bryce, jun. Esq. M.A. Member of the Belfast Natural History Society, &c., and communicated by Roderick Impey Murchison, Esq. Pres. G.S.



May 16.—On the Geological Relations of the stratified and unstratified groups of Rocks composing the Cumbrian Mountains; by the Rev. Adam Sedgwick, V.P.G.S. F.R.S. Woodwardian Professor in the University of Cambridge.

May 30.—On the Basalt of the Titterstone Clee Hill, Shropshire; being the concluding part of a Memoir on the Ludlow district, laid before the Society on the 29th of February; by J. Robinson Wright, Esq. F.G.S. employed on the Trigonometrical Survey.

———— On a large Boulder Stone on the shore of Appin, Argyleshire; by James Maxwell, Esq., and communicated by William Smith, Esq. F.G.S.

———— On the Discovery of Bones of the Rhinoceros and a Hyæna in one of the Cefn Caves, situated in the Vale of Cyffredan, Denbighshire; by the Rev. Edward Stanley, F.G.S.

June 13.—Observations on the London Clay of the Highgate Archway; by Nathaniel Thomas Wetherell, Esq. F.G.S.

———— On the Discovery of portions of three Skeletons of the Megatherium, in the province of Buenos Ayres in South America; by Woodbine Parish, jun. Esq.; followed by a Description of the Bones; by William Clift, Esq. F.G.S.

November 7.—On some intersections of Mineral Veins in Cornwall, in a Letter to Davies Gilbert, Esq. M.P. F.G.S.; by W. J. Henwood, Esq. F.G.S.

———— An Account of a Sub-marine Forest in Cardigan Bay; by the Rev. James Yates, F.G.S.

November 21.—On the Geology of the North Coast of the Counties of Mayo and Sligo; by the Venerable Archdeacon Verschoyle.

———— A Communication from the Rev. Adam Sedgwick, V.P.G.S., respecting certain Fossil Shells overlying the London Clay in the Isle of Sheppey.

December 5.—On the Remains of the Iguanodon, and other Fossil Reptiles of the strata of Tilgate Forest in Sussex; by Gideon Mantell, Esq. F.G.S.

———— 19.—Report of a Survey of the Oolitic Formations of Gloucestershire; by William Lonsdale, F.G.S.

January 9, 1833.—Observations on Coal; by W. Hutton, Esq. F.G.S.

———— A Communication “On Ophiura found at Child’s Hill, to the north-west of Hampstead;” by Nathaniel Thomas Wetherell, Esq. F.G.S.

January 23.—On a portion of the Deccan, East Indies; by Lieut.-Col. W. H. Sykes, F.G.S.

———— A Letter addressed to the Rev. Professor Buckland, D.D. V.P.G.S. by Joshua Trimmer, Esq. F.G.S. respecting the Discovery of Marine Shells of existing species on the left bank of the Mersey, and above the level of the high-water mark.

*Sums actually Received and Expended,*

## RECEIPTS.

Balances in hand Jan. 1, 1832 :	£.	s.	d.	£.	s.	d.
Banker (including 71 <i>l.</i> 17 <i>s.</i> 8 <i>d.</i> Wollaston Fund).....	457	2	8			
Accountant.....	40	0	0			
	<hr/>			497	2	8

Arrears :	£.	s.	d.			
Admission Fees .....	98	14	0			
Annual Contributions .....	101	1	0			
	<hr/>			199	15	0

Ordinary Income :	£.	s.	d.			
Annual Contributions .....	464	18	6			
Admission Fees :	£.	s.	d.			
Residents .....	182	14	0			
Non-Residents. ....	84	0	0			
	<hr/>			266	14	0
	<hr/>			731	12	6

Compositions, six .....	189	0	0
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	£.	s.	d.	£.	s.	d.
Transactions.....	124	5	0			
Ditto, due from Messrs. Treuttel and Co. for copies sold during 1831.....	37	12	4			
	<hr/>			161	17	4
Proceedings .....		3	2	0		
	<hr/>			164	19	4

Wollaston Fund .....	32	10	4
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£1814 19 10

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during the Year ending December 31, 1832.

# PAYMENTS.

Bills outstanding Jan. 1, 1832 :	£.	s.	d.	£.	s.	d.
Taxes .....	14	5	0			
Gas Company .....	7	4	6			
Curator's Salary .....	50	0	0			
Stationery .....	0	15	7			
Scientific Expenditure .....	7	14	0			
					79	19 1

General Expenditure :	£.	s.	d.
Household Furniture .....	7	19	0
Repairs of House .....	5	7	5
House Expenses .....	190	14	9½
Taxes, Parochial .....	25	5	0
—, King's .....	52	11	4
Insurance .....	6	0	0
	287	17	6½

Salaries and Wages :	£.	s.	d.
Curator .....	150	0	0
Porter ... ..	70	0	0
	220	0	0

Scientific Expenditure .....	29	3	2
Stationery and Miscellaneous .....			
Printing .....	35	16	4
	64	19	6

Tea for Meetings .....	42	13	2½
	615	10	3

Cost of Publications :	£.	s.	d.
Transactions .....	161	12	2
Proceedings .....	39	0	0
	200	12	2

Balances in hand Jan. 1, 1833 :	£.	s.	d.
Banker (including 104 <i>l.</i> 8 <i>s.</i> Wollaston Fund) ..	878	17	4
Accountant .....	40	1	0
	918	18	4
	£1814	19	10

## VALUATION of the Society's Property; 31st December 1832.

PROPERTY.			DEBTS.		
	£.	s. d.	Bills outstanding:	£.	s. d.
Balance in hand (see p. 433).....	918	18 4	Taxes.....	15	0 0
Arrears due to the Society:			Salaries and Wages.....	75	0 0
Admission Fees.....	107	2 0	Collector's Poundage.....	33	0 0
Annual Contributions.....	268	16 6	Petty Expenses for Dec. 1832..	30	15 3
	375	18 6	Ironmonger's Bill.....	3	18 3
Estimated value of unsold Transactions.....	638	6 0	Treuttel and Co.....	3	0 0
Due from Treuttel and Würtz, on account of			R. Taylor, Printing.....	12	2 0
Transactions sold.....	97	2 8	Wyon, for Wollaston Dies and Medal.....	63	0 0
	2030	5 6	Cash belonging to "Wollaston Fund".....	235	15 6
			Arrears not likely to be received.....	41	8 0
			Balance in favour of the Society.....	75	0 0
				1678	2 0
				2030	5 6

[N.B. The value of the Collections, Library, and Furniture is not here included: nor is the "Donation Fund" instituted by the late Dr. Wollaston, amounting at present to 108*4*l. 1*s.* 1*d.* in the Reduced 3 per cent. Annuities; the dividends thereof being appropriated to the purposes suggested by the Founder.]

We have compared the Books and Vouchers presented to us, with these Statements, and find them correct.

Jan. 31, 1833. Signed, J. WILLIMOTT, }  
C. STOKES, } AUDITORS.

JOHN TAYLOR, TREASURER.

## ESTIMATES for the ensuing Year 1833.

INCOME EXPECTED.			EXPENSES ESTIMATED.	
	£. s. d.		£. s. d.	
Arrears due to the Society, Dec. 31, 1832 (see p. 434)	375 18 6	Debts outstanding Dec. 31, 1832 (see p. 434) . . .	235 15 6	
Ditto from Treuttel and Co. on account of Transactions sold . . . . .	97 2 8	General Expenditure :		
Ordinary Income for 1833 (estimated) :		Repairs of House . . . . .	50 0 0	
Contributions of 150 Fellows . . . . .	470 0 0	Taxes . . . . .	95 0 0	
Admission Fees :		Insurance . . . . .	6 0 0	
Residents (20) . . . . .	126 0 0	House Expenses . . . . .	190 0 0	
Non-Residents (15) . . . . .	157 10 0	Household Furniture . . . . .	25 0 0	
	<u>283 10 0</u>		<u>366 0 0</u>	
Compositions (three) . . . . .	94 10 0	Salaries and Wages :		
		Curator } . . . . .	200 0 0	
		Clerk } . . . . .	100 0 0	
		Porter and Servant . . . . .	20 0 0	
		Collector's Poundage . . . . .	20 0 0	
		Scientific Expenture, Cabinets, and Bookshelves	150 0 0	
		Stationery and Miscellaneous Printing . . . . .	50 0 0	
		Tea for Meetings . . . . .	45 0 0	
		Cost of Publications :		
		Transactions . . . . .	200 0 0	
		Proceedings . . . . .	50 0 0	
			<u>250 0 0</u>	
Sale of Transactions . . . . .	200 0 0	Arrears not likely to be received . . . . .	75 0 0	
Dividends on "Wollaston Donation Fund" . . . .	32 10 4	Employment of the "Wollaston Donation Fund"	32 10 4	
		Balance in favour of the Society . . . . .	29 5 8	
	<u>£1553 11 6</u>		<u>£1553 11 6</u>	

The Reports having been read, it was Resolved:—

1. That these Reports be received ; and that such parts of them as the Council shall think fit, be printed and distributed among the Fellows of the Society.

2. That the thanks of the Society be given to Roderick Impey Murchison, Esq., retiring from the office of President.

4. That the thanks of the Society be given to the Rev. Professor Buckland, D.D., and the Rev. William Daniel Conybeare, respectively, retiring from the office of Vice Presidents.

4. That the thanks of the Society be given to William Clift, Esq., Robert Edmund Grant, M.D., Capt. Basil Hall, R.N., Charles Stokes, Esq., and the Rev. William Whewell, retiring from the Council.

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The Meeting then proceeded to ballot for the Officers and Council for the ensuing year ; and on the glasses being closed, the scrutineers announced that the following gentlemen had been duly elected :—

## OFFICERS.

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### *PRESIDENT.*

George Bellas Greenough, Esq. F.R.S. L.S. & H.S. M.R.A.S.

### *VICE-PRESIDENTS.*

William John Broderip, Esq. B.A. F.R.S. & L.S.

Henry Thomas De la Beche, Esq. F.R.S. & L.S.

William Henry Fitton, M.D. F.R.S. & L.S.

Rev. Adam Sedgwick, M.A. F.R.S. Woodwardian Professor in the University of Cambridge.

### *SECRETARIES.*

Edward Turner, M.D. F.R.S. L. & E. Professor of Chemistry in the University of London.

William John Hamilton, Esq.

### *FOREIGN SECRETARY.*

Charles Lyell, Esq. F.R.S. & L.S. Professor of Geology in King's College, London.

### *TREASURER.*

John Taylor, Esq. F.R.S.

## C O U N C I L.



George William Aylmer, Esq.	Right Hon. Earl Fitzwilliam,
Rev. William Buckland, D.D.	F.R.S.
F.R.S. & L.S. Professor of	Davies Gilbert, Esq. M.A. F.R.S.
Geology and Mineralogy in	S.A. L.S. & H.S. Hon. Mem.
the University of Oxford.	R.S. Ed. M.R.I.A.
Francis Chantrey, Esq. D.C.L.	R. I. Murchison, Esq. F.R.S. L.S.
F.R.S. S.A. & H.S.	J. W. Pringle, Esq. Capt. R.E.
Rev. William Daniel Conybeare,	W. Somerville, M.D. F.R.S. L.
M.A. F.R.S.	& E. & F.L.S.
Viscount Cole, M.P. F.R.S.	Henry Warburton, Esq. M.P.
Charles Daubeny, M.D. F.R.S.	F.R.S. L.S. & H.S.
Sir Philip Egerton, Bart. F.R.S.	Rev. James Yates, M.A. F.L.S.

*Address to the Geological Society, delivered on the Evening of the 15th of February 1833, by RODERICK IMPEY MURCHISON, Esq. F.R.S. L.S. &c., on retiring from the President's Chair.*

GENTLEMEN,

TWENTY-FIVE years only have elapsed since this Society was first formed under the auspices of Mr. Greenough and a few zealous naturalists.—In the year 1826, when your Charter was obtained, the number of Members had already reached 476, and since that period a still more rapid increase has taken place, which has now swelled our list to 694. This remarkable yet steady augmentation of our forces is the best proof of the estimation in which your labours are held; and it further shows, that the pursuits of the geologist are no longer viewed as purely speculative, but are at length considered as essentially connected with the development of the national resources.

The past Session has been fatally marked by the decease of three distinguished geologists.

The Rev. Benjamin Richardson, of Farley near Bath, one of the earliest Members of this Society, was a man of great singleness of character and generosity of disposition, and, as a cultivator of science, he was distinguished by the extent of his knowledge,—not drawn from books, but from an examination of Nature in her own domains. In the pursuit of geology he was well instructed from his own researches; but he was ever delighted to tell that he owed his first clear ideas of the subject to William Smith; and his latter days were gladdened by knowing that the merits of his friend had been acknowledged by this Society. To his generosity of disposition our museum, and those of many local institutions, are deeply indebted. He collected only that he might give away; and, regardless of all personal fame, he never failed, when a discovery was made, to call around him those who could profit by it. Thus, though he was never seen among us, and though his name was rarely heard, he was steadily labouring in our cause, and silently, but effectually, urging it on.

I have next the painful duty to record the death of the venerable Sir James Hall, one of that bright constellation of philosophers which arose in Scotland towards the end of the last century.

The intimate friend of Hutton and of Playfair, he eagerly imbibed the opinions of these celebrated men, and satisfied himself of the leading truths in the Huttonian theory by extended and patient examinations of geological phenomena,—not merely amongst the British Isles, but in the Alps, in Italy, and in Sicily. The result of these observations was communicated in a series of Memoirs read before the Royal Society of Edinburgh, of which distinguished body he was for many years the President. In alluding to these Memoirs, I at once remind you how materially he assisted in demonstrating that a certain class of granitic veins had been injected into the overlying deposits posterior to their consolidation. He endeavoured to explain



experimentally the contortions of certain strata, and the manner in which the phænomena had been effected by upheaving forces acting under compression. He subjected various rocks of igneous origin to chemical analysis, and succeeded in establishing their relative degrees of fusibility. He gave an original and perspicuous account of the true mode of formation of volcanic cones; and whilst he pointed out that Monte Somma was simply the segment of a vast volcano, from the flank of which the present Vesuvius had arisen, he showed the intimate analogy between the dykes of lava of the former and the ancient trap-dykes of our continents. If, in tracing the revolutions of the surface of the earth, he was led to attribute too much to the influence of one great diluvial current, we must recollect that in this, his only dereliction from the principles of Hutton, his conclusions were founded on a striking class of phænomena first observed by himself; and that the diluvial theory (though in a modified sense) has still the support of many of our most eminent geologists. To a mind so accustomed to speculate upon the intense energy of volcanic phænomena, it was a natural inference that the fractures and dislocations of mountain-masses have been produced by paroxysmal efforts of nature,—in short, by mighty earthquakes, and their accompanying elevations, depressions, and eruptions.

Much, however, as we owe to him for his many accurate observations of nature, our debt of gratitude must specially be acknowledged for his successful application of chemistry to geology, without which, one essential condition of the theory of Hutton would not have been established, as it now is, upon an immovable basis. The important discovery of carbonic acid by Black, which was destined to lead to the solution of many occult terrestrial phænomena, was at first cited by the Wernerians as destructive of the very basis of the theory of the igneous consolidation of the strata of the earth, it appearing impossible to explain the formation of crystalline marble from earthy carbonate of lime, by the very agent which drives off the gaseous constituent in every lime-kiln. To obviate this difficulty, the founder of the new theory propounded, that the heat by which rocks had been solidified was applied under enormous pressure; that in consequence effects had taken place entirely differing from those which manifest themselves under the mere pressure of our atmosphere; and that under such circumstances carbonate of lime might have been reduced to a state of fusion without calcination. Though the genius of Hutton had thus divined the true cause of the phænomena in dispute, that great man shrunk from the prosecution of experiments which might prove the truth of his hypothesis, being persuaded that the immensity of natural objects was far beyond the reach of man's imitation. It was reserved for Hall to have the glory of demonstrating the truth of the doctrine of his friend;—"the conjectures of genius," as he tells us, "at length ceased to appear extravagant; the mist which obscured the objects being dissipated by degrees, they appeared in their true colours, and a distant prospect opened to his view of scenes before unsuspected." To his ardent mind the realization, upon the surface of the earth, of that which had occurred below the deep abyss

of the ocean, was not a hopeless effort, and he commenced a series of experiments which occupied a long period of his life,—were conducted with undaunted perseverance, and with a surprising fertility of invention, until he completely triumphed in fusing earthy carbonate of lime under vast pressure, producing from it a pure and crystalline marble. In establishing this fact, he turned the weapons of his opponents against themselves, and paved the way for the reception, among all the philosophers of Europe, of the leading doctrines which he advocated.

The gradual decay attendant upon advanced age, had prepared us in some measure for the other losses we have sustained ; but Cuvier has been snatched from us when his comprehensive intellect was in its fullest vigour, and without any of those warnings by which both body and mind, are wont to announce that their mortal race is nearly run.

The death of such a man has called forth deep lamentations from every land upon whose children the rays of science have shed their light, and the eulogies poured forth in his honour are heard in almost every language of the civilized globe. How are we to limit our praise of one whose ample mind was matched only by the benevolence of his heart, and whose whole life was passed in unremitting exertions to enlarge the domain of science by blending it with civil polity, and by infusing it into the principles of education ? With an almost incredible knowledge of the structure and functions of every part of organic nature, he possessed a power above that of every other man of emancipating himself from mere details, and of ascending to lofty generalizations, which were ever recommended by him with all the charms of eloquence ; so that in his hands natural history became adorned, for the first time, with the highest attributes of pure philosophy. To him we owe the most important of the laws which have regulated the distribution of the animal kingdom, and by the application of which we have been made to comprehend many of the mutations of the surface of our planet. He it was who, removing from geology the incumbrance of errors and conceits heaped on it by cosmogonists, contributed more than any individual of this century to raise it to the place which it is assuming amongst the exact sciences. Unlike our precursors, we no longer have to wade through the doubts and perplexities which retarded their acquaintance with the lost types of creation ; to his skill we are indebted for a knowledge of their analogies with existing races ; and he it was who, from their scattered bones, remodelled the skeletons of those wondrous originals which have successively passed away from the surface of our planet.

Those among us who have enjoyed the honour and delight of social intercourse with this great man will ever remember his suavity of manner,—his lucid power of exposition,—in short, that intellectual bearing which served to impress all listeners with the feeling, that every province of natural truth was within the grasp of his mighty thought.

The extent to which English geologists have profited by his in-

structions is recorded in the volumes of your Transactions, and a mere recapitulation of such of his writings as illustrate our subject is uncalled for on this occasion ; but I cannot avoid remarking, that a Memoir on Zootomy, lately read before us, has proved a posthumous tribute to his fame. Of all the comparisons which he had instituted in his *Ossemens Fossiles* between the lost and living species, no one showed more ingenuity, and deep acquaintance with the laws of animal oeconomy, than that in which he pointed out the close analogy subsisting between the gigantic Megatherium of South America, and the existing tribe of Sloths.

Well, therefore, may English geologists rejoice, that the discovery of another individual of this species has enabled one of our Fellows, eminent for his skill in comparative anatomy, to confirm the views of our great zoological master.

Thus, Gentlemen, the name of Cuvier, associated, as it has been, with discoveries forming the true basis of geology, is also interwoven with the most recent advances of this Society ; and, as an appeal is now made to the naturalists of all nations to unite in a tribute to his memory, may those who have reaped such fruits of his genius, and are so justly proud of having sympathized in his living fame, hasten to record their obligations on the pedestal of that monument which is to be erected on the field of his greatest glory.

I now proceed to lay before you a sketch of the progress of geology in our own country during the past year. Deviating from the chronological order in which the different memoirs were considered at the last anniversary, I shall on this occasion, for the sake of greater perspicuity, class them under scientific heads : in so doing, I shall endeavour to connect our advances with the general progress of geology upon the continent, by passing allusions to such works of foreigners as the active nature of my own employment has permitted me to consult.

**RECENT DEPOSITS.**—In the class of historic alluvia, the Rev. J. Yates has described a partially submerged and ancient forest near the mouth of the river Dovey, chiefly composed of the *Pinus sylvestris*, and supposed to have been destroyed by the accidental demolition of a sea-dyke. A similar case of a submerged wood had previously been traced on the shores of Hampshire by Mr. C. Harris, who in communicating the discovery to Mr. Lyell, has proposed a most ingenious and probable explanation of the cause of these appearances\*.

In attempting to account for the existence of large and shady forests on spots where the coasts are now entirely shorn of vegetation, we must embrace in our consideration the similar phænomena which are so numerous, as almost to form a submarine fringe around our island ; and from these we may conclude, that when the whole country was densely clothed with wood, the forests might have ex-

\* Principles of Geology, vol. ii. p. 274, Second edition.

tended their limits in full vigour to marine tracts, where single trees will no longer flourish.

You were last year made acquainted with the existence, at various places, of accumulations of sand, gravel, and clay, containing existing species of marine shells, placed at different heights above the sea; and a subsequent Memoir of Mr. Trimmer on a part of the estuary of the Mersey describes the presence of fragments of shells of existing species, in a stratum of sandy clay, containing numerous erratic pebbles, and a few boulders.

Having myself traced beds with recent sea-shells at considerable and various heights above the sea, both on our eastern and western coasts, I am disposed to think that there is already sufficient evidence of our shores having undergone elevation at periods comparatively recent, however difficult it may be to explain all such superficial accumulations upon a similar hypothesis.

If the coasts exhibit testimonies of such elevations, the evidence is corroborated when we follow the course of those indentations which penetrate far within the interior of the island. In most of these we perceive accumulations of shingle and sand on the sides of valleys, some of which, by the fine lamination of their beds, indicate long-continued and tranquil formation; others, by the shivered and fragmentary condition of their contents, bespeak a more tumultuous mode of aggregation: the latter, therefore, were probably coincident with periods of elevation of the land, which throwing up the shores of the island, have converted former estuaries into existing plains, bounded by ancient shores of gravel, leaving the rivers to meander between their widely separated banks.

If such phænomena be still traceable within this island, where the subterranean energies of nature are now, and have been for so long a period quiescent, what amount of valuable instruction may we not hereafter derive from the presence of good observers in those countries where volcanos and earthquakes, with their accompanying elevations and depressions, are in frequent activity? You are already aware of the important services of Mr. Lyell, and how effectually he has attracted attention to this branch of inquiry. I would further remind you of the discoveries of M. de Boblaye, who has placed the successive elevations of land in a remarkably clear light, by showing the existence in the Morea of four or five distinct ranges of ancient sea cliffs, marked at different levels in the limestone escarpments by lithodomous perforations, lines of littoral and sea-worn caverns, and other striking proofs of former tidal action.

The description of a large granitic boulder, by Mr. Maxwell, resting on the slaty shores of Appin, in Argyshire, leads me to observe, that the numerous detached masses of rock, foreign to the districts in which they are scattered through Northern Germany and Westphalia, have met with an additional expositor of their origin in Professor Hausmann, of Göttingen, who, coinciding in the views of M. Brongniart and others, is of opinion that these fragments have been derived from the mountains of Sweden.

M. A. De Luc has again come before the public, with a Memoir on

the gravel and other transported materials of the basin of Geneva; being a second part of his former essay on the same subject. He indicates the localities in which the fragments of different rocks have originated, showing that although some have been drifted from the east, and others from the west, many of them are probably remnants of those calcareous mountains which were shattered on the spot, at that period of dislocation, when by the expulsion of their debris, that great cavity was formed, which is now occupied by the lake. The superficial sediments of the basin are said to vary much in their composition; whilst their beds are inclined in all directions, thereby indicating the effects of numerous and conflicting currents of water, which in some cases have hurled down large boulders of primary rock from the higher Alps, and in others have heaped up the finer alluvia derived from the adjacent secondary formations. All these phenomena are supposed by the author to have been caused by debacles incident to lengthened periods in which the surrounding mountains were forcibly and violently elevated.

From these and other writings of the present day, we perceive that correct observations have now established, that the diluvial and transported detritus of each great geographical division of Europe, when viewed on a great scale, can for the most part, be traced to an axis of elevation within that region; so that as each great mountain-chain has been the source of the detritus covering the adjacent low country, we can no longer attribute such drifts of sedimentary matter to one particular diluvial current, which has acted in any given direction.

However indisposed, therefore, the diluvialists may be to adopt as a full and satisfactory explanation of these appearances the modified view of the theory of diurnal action of Hutton, as put forth by Mr. Lyell, the dispassionate reasoner must admit, that the question between the diluvialist and the advocate of existing causes is fast resolving itself into one of amount or intensity of forces. Each party has now recourse to modern analogies in referring changes between the levels of sea and land to eruptions from beneath; and he who is unwilling to quit a path of induction pointed out, as he believes, by nature, invokes only *repeated* shocks of earthquakes, elevations, and depressions, in preference to a *limited* number of stupendous catastrophes insisted upon by his antagonist.

**TERTIARY DEPOSITS.**—In the illustration of tertiary geology, I may announce to you, that the last pages of the Third Volume of the Principles of Geology, by Professor Lyell, are in the press. In this volume, which I have perused, the author successfully applies to the tertiary formations the principles laid down in the two first volumes. He subdivides these younger deposits into four natural epochs, founded upon a mass of zoological evidence infinitely more comprehensive, and yet more precise than any which has ever been brought before us. In treating chronologically of alluvial, fresh-water, marine, and volcanic phenomena, a wide range is afforded for the development of his extensive knowledge and observation; enabling him to ground his rea-

sonings on countries visited by himself, and to interpret the handwriting which Nature has left upon the walls of her geological monuments, in such a manner as not only to expound her ancient records, but to connect them with the history of our present races.

Although this volume is devoted chiefly to the description of the younger formations, as more intimately connected with the main object of the author, the secondary and primary rocks are reviewed so far as was necessary to show their connexion with his theory, and to indicate how well their structure can be accounted for by causes, which he supposes to be still in full and undiminished operation. The powerful effects produced upon the public mind by the first and second volumes of this work will, I may venture to say, be highly augmented by a perusal of this concluding part; and even those geologists who may differ from the author on a few theoretical points, will gladly eulogize the efforts of one who has so greatly advanced their knowledge.

**FOSSIL ZOOLOGY.**—The Session has been fertile in communications upon fossil zoology. The splendid specimens of *Megatherium*, &c. brought to this country by Mr. Woodbine Parish have, in the hands of Mr. Clift, afforded us much curious instruction. The tribute which these remains enabled Mr. Clift to pay to his great master in comparative anatomy, has already been adverted to; but we must not forget that they also elicited brilliant lectures from Dr. Buckland, both within these walls, and on the occasion of the late scientific festival at Oxford.

The Rev. Mr. Stanley has given a lively description of the caves of Cefn, in Flintshire, one of which, like that of Kirkdale, is supposed to have been the inhabited den of hyænas; whilst another and larger cavern, situated at a lower level on the side of the same mountain, contained only the remains of recent animals. From the distinct nature of the upper and lower layers of alluvia collected within the inhabited cave, and arranged above and below the floor of fossil bones, the author speculates on layers as evidences of different periods of aqueous debacle.

Mr. Mantell, whose energies seem to expand in each succeeding year, notwithstanding the limited field to which his researches are necessarily confined, has presented us with an account of an undescribed and singular species of Saurian, to which he assigns the name of *Hylæo-saurus*. This fortunate exhumation has, I am happy to say, encouraged the enterprising ranger of Tilgate Forest to make it the nucleus of a new and comprehensive work, in which he will not only describe all the vertebrated animals in his rich domain, the Wealds of Sussex, but will embrace in it a geological description of his own, and of the adjoining counties.

The bright example of Mr. Mantell is meeting with worthy imitators in other parts of England, in the persons of other zealous young members of the same profession, among whom may be mentioned Mr. Channing Pearce of Bradford, and Mr. T. Hawkins of Glastonbury;—the first of whom has collected and arranged a vast number of new species of the organic remains in his neighbourhood; the latter,

within the short space of two years, has disinterred numerous fine Saurians from the lias: among these we recognise a *Plesiosaurus*, so perfect, that it serves to commemorate the skill of Mr. Conybeare, whose elaborate restoration of the skeleton from one imperfect specimen is now amply confirmed.

A recent discovery of Miss Mary Anning, that indefatigable purveyor to the store-houses of our science, has furnished Mr. T. Hawkins with the disjointed fragments of an animal, which upon being reintegrated, proves to be the largest individual of the *Ichthyosaurus platyodon* ever yet found entire upon our shores.

Two Members of your Council, Viscount Cole and Sir Philip Egerton, have for some years entered zealously into the pursuit of fossil zoology, and have reaped a rich harvest, both on the continent and at home, having with their own hands brought to light some osseous relics unknown even to Cuvier.

If these are among the latest fruits of fossil zoology in England, our coadjutors on the continent have not relaxed their efforts. I had formerly occasion to direct your attention to that invaluable work, the *Conchological Classifications* of M. Deshayes; and I ought at the same time to have noticed a most useful and clear production of the same author, entitled *Coquilles Caractéristiques des Terres*.

The "Mémoires Palæontologiques" of M. Boué, which embraces memoirs from all countries, may, it is to be hoped, in great measure supply the loss which must have been deeply felt by every practical geologist, in the cessation of that most useful periodical the *Bulletin Universel des Sciences*.

M. Pentland, from the examination of a collection of fossil bones which had been consigned to his deceased friend, Baron Cuvier, has enlarged our acquaintance with the Fauna of Australia, by the addition of several new and undescribed species of animals, principally marsupial.

The "Palæologica" of M. Hermann Von Meyer, of Frankfort, brings together, in a synoptical form, all our present stock of knowledge of extinct vertebrated animals; and being a compendious index to all the works written upon this subject, must be considered a necessary portion of every geological library.

Our distinguished Foreign Associate Von Buch has just produced a work upon Ammonites, which is intended to simplify the natural arrangement of this obscure class of fossil bodies.

A blank in fossil zoology is about to be filled up by Dr. Agassiz, of Neufchatel, whose work on "Fossil Fishes" will furnish us with materials which we looked for from the pen of the lamented Cuvier. Precise anatomical distinctions, even to the minutest forms of the scales, will be so considered in this work, that the learned Professor hopes to realize the application of the system of his great instructor, and from the forms of parts to enable us to decide upon the specific character of the entire fish to which they belonged. The short sketch\* by this author of the fishes of Eningen and of the

\* Jahr. Buch, 1832, Dritter Jahrgang Zweites Quartal-Heft.

lias, may lead us to a favourable anticipation of the success of his forthcoming volumes,—and to hope that fossil ichthyology may hereafter serve our cause as efficiently as other branches of zoological evidence.

**FOSSIL PLANTS.**—The early experiments of Hall and Hatchett, amplified and illustrated by MacCulloch, had nearly produced conviction that all the varieties of carbonaceous matter, from the ill-consolidated *surturbrand*, through every stage of brown coal to pure jet; and in our older strata from anthracite to bituminous coal, were the products of vegetables. Botanists have since corroborated the soundness of these views, by developing the Flora of the associated strata; and one of our body has enabled us to refer many of these plants to their natural families in living nature, by an ingenious method of exhibiting polished sections of their stems: but it has been reserved to Mr. W. Hutton in pursuing this line of inquiry, to complete the solution of the problem by demonstrating the vegetable structure in coal itself. The Memoir of Mr. W. Hutton is further of high and practical utility in describing the source of those enormous volumes of imprisoned gases, which upon admixture with our atmosphere become explosive, and occasion such disastrous results to our miners.

As a slight contribution towards a knowledge of the condition of the surface of the earth during one of the periods in the formation of the oolitic series, which is marked by its vegetation, I offered to you a few remarks on the vertical position of the stems of *Equiseti*, in a sandstone of the eastern Moorlands of Yorkshire. This phenomenon extending over a large area is analogous to that observed in the Isle of Portland by Dr. Buckland and Mr. de la Beche; from which however it differs, as it appeared to me, in requiring for its explanation the desiccation of submarine sediments, so as to leave a stagnant marsh for the place of growth of these plants; which, after this marsh had been gradually silted up, were submerged by a fresh irruption of the sea, accumulating above them the deposits of the middle and upper oolite.

**GENERAL GEOLOGY AND PHYSICAL GEOGRAPHY.**—Geologists have long felt that a period would arrive, when every geographer would seek to obtain a competent acquaintance with what may be termed the anatomy of his subject; and it is therefore gratifying to remark, that the past year has been prolific in works explanatory of the intimate association of geology with the physical geography of Great Britain.

**ENGLAND.**—The encouragement which, at the suggestion of Colonel Colby, the Board of Ordnance has afforded to all the surveyors who, during their labours in the field, have kept a register of the mineral changes accompanying variations of outline in the land, is now producing the happiest results.

Mr. Wright has already given us ample proof of this, in the geological



delineation of a tract of country around Ludlow, which, from repeated personal examination, I can testify to be a model of accuracy.

Mr. Maclauchlan, another of our Fellows, attached to the Ordnance Survey, has with equal success illuminated a much larger surface of the Ordnance maps, comprehending the Forest of Dean, and the central parts of Herefordshire. His details respecting the rich coal-field in the Forest of Dean are of singular value, being derived from the observations of so experienced a miner as Mr. Mushett.

Our Society has further been most advantageously connected with the Ordnance Survey, by the appointment of Mr. De la Beche to affix geological colours to the maps of Devonshire, and portions of Somerset, Dorset, and Cornwall. From our acquaintance with the skill of this geologist, and from his long practice in the districts which he has undertaken to represent, it is certain that he will furnish many striking examples of the value of well-defined physical features, in enabling the geologist to explain the relation of the present outline of the land to ancient subterranean movements.

The adoption of a fixed scale of colours by all English geologists is still an essential desideratum in this department; and I am happy to have it in my power to state, that a systematic arrangement will shortly be submitted to you, after it has undergone the supervision of our Council, and shall have met with the approval of the Board of Ordnance. This scale, being founded on the principle of employing such colours only as are fixed and distinct from each other, has been suggested by our valued member Mr. Chantrey, who, by this highly useful appropriation of his leisure moments, has augmented those claims upon our gratitude which he had established by many acts of good fellowship, and the devotion of his time and talents to our cause.

Through the early investigations of William Smith, the oolitic series was divided into sub-formations; and, by the subsequent adoption of these subdivisions by Conybeare, their provincial names have become classic throughout Europe, and have served to commemorate the discernment of him who first taught us to identify strata by their organic remains.

At the last anniversary it was announced that, with entire confidence in his qualifications, your Council had fixed upon Mr. Lonsdale to commence a task, the prosecution of which they conceived to be strictly consonant to the spirit of the bequest of the lamented Wollaston; by which we are endowed with the means of rewarding those who enlarge the circle of geological knowledge. Mr. Lonsdale has presented us with the result of his labours, having laid down upon maps of the Ordnance Survey the range of different members of the oolite, from the neighbourhood of Bath, where he had previously developed their relations, to the southern limits of Warwickshire and Oxfordshire. The success attendant upon this undertaking has already been made apparent in the maps, sections, and remarks of our Curator. By these you will perceive he has already demonstrated that the upper shale and marl-stone of the lias, which are only visible as mere beds

in the neighbourhood of Bath, swell out rapidly in their north-eastern course, and soon assume the same characters which Mr. Phillips has assigned to them in Yorkshire. He next establishes that the whole of the fine-grained white oolite in the escarpment of the Cotteswold Hills, although lithologically undistinguishable from the great oolite of Bath, is only an expansion of the inferior oolite. It is then made apparent that the Fuller's earth disappears entirely to the north of Gloucestershire; and the highest degree of interest is added to these groups, by determining, for the first time, the true position of the Stonesfield slate, which he shows to be the base of the great oolite; thus removing it from the geological horizon, in which, from the obscure sections at Stonesfield, it had before been placed. Such are a few of the evidences of the good already derived from the revision of this series of our formations by a geologist like Mr. Lonsdale, who, to the eye of an unerring observer, adds the rare qualifications of a thorough acquaintance with specific distinctions in organic remains.

But the value of such a work is not to be measured by reference to English geology alone; for, if it be now ascertained that the oolitic groups are made up of members which inosculate with each other, expanding to vast thicknesses, or thinning out entirely, within the limited range of two counties; and that even its principal formations cannot be followed into Yorkshire, still less to Brora and the Hebrides, without exhibiting great changes in their mineral and fossil contents; we can scarcely hope to identify each subordinate member of our own country with the subdivisions of the series on the continent of Europe. I willingly express this opinion, although it may seem to be slightly at variance with a surmise I ventured to advance last year respecting the age of the lithographic stone of Solenhofen. That comparison was intended simply to afford the English geologist an approximate idea of the age of a rock, which, by some of my countrymen, had been considered as of tertiary origin, by others, as belonging to the green-sand; so that if my rough estimate should prove less accurate than that of a distinguished Prussian\*, who has since compared it with the coral rag, I shall still feel satisfied in having first pointed out to the English inquirer, that the Solenhofen slate is a member of the Jurassic or oolitic system, and that, from the general similarity of many of the organic remains, such as Pterodactyli, Crustaceæ, and certain plants, it is probably the equivalent of the Stonesfield slate, or one of the central and slaty members of this complex series. On a broad scale, however, I feel persuaded, that a simple division into "*upper*" and "*lower*" oolitic systems is the full extent to which we can bring continental and British formations of this age under comparison.

To Dr. Fitton we are indebted for his "Notes on the Progress of Geology," in which the relative merits of the founders of the science in England are well put forth; and also for his "Geological Sketch of the Vicinity of Hastings," a most valuable addition to those local monographs which contribute so largely to the diffusion of precise

information. I rejoice to see this powerful geologist once more before us as an author, and still more when it is announced, in this last useful work, that a series of figures, including all the undescribed species of the shells of the Wealden formations, will appear in the volume of the Geological Transactions now in the press, with a comprehensive Memoir upon the formations between the chalk and the oolites, the publication of which has been so loudly called for by foreign and native geologists.

The results of my own observations during the last two summers are about to be offered to you, in a detailed description of the upper fossiliferous grauwacke, and its relations to the overlying deposits, with descriptions of the intrusive rocks by which the series has been penetrated. The zone examined, comprehends the western parts of Shropshire and Herefordshire, and passing to the south-west, through Radnor and the wildest tracts of Brecknockshire, terminates in the mouth of the Towey in Caermarthenshire. As considerable spaces within this zone have not yet been laid down for publication in the Ordnance map, it is obvious that without the extraordinary aid, which has been so cheerfully afforded me by Capt. Robe, and other officers of His Majesty's Map-office, and also by that excellent field surveyor Mr. Budgin, little progress could have been made in the performance of a work, which, when completed, will I trust meet with your approbation\*.

In the communication explanatory of these coloured maps, I hope to prove that the old red sandstone, with few exceptions, passes down into, and is conformable to, those rocks, to which we have been accustomed to apply the term "Transition;" and that, throughout great areas, the old red sandstone is equally conformable to the overlying carboniferous limestone as to the underlying grauwacke;—that the fossiliferous grauwacke is divided into a number of large natural formations or groups, charged with a variety of organic remains, for the most part undescribed. In tracing the lines of disturbance which have affected these deposits, flexures upon a gigantic scale will be pointed out, whereby the old red sandstone has been thrown into basins of elevation, and, by a reversed inclination, extended to the westward, far within the escarpment of the grauwacke; and these lines of disturbance and elevation will then be delineated, and their relation traced to ridges of intrusive rocks.

Whatever merit these observations may possess, they cannot but derive value from being linked with the contemporaneous investigations of Professor Sedgwick, amid the adjoining regions of grauwacke, slate, and older rocks of the Welsh mountains.

This will become evident when the Professor shall exhibit to you

\* This memoir owes the most valuable portion of its zoological illustrations to the Rev. T. Lewis of Aymestrey. Colonel Wingfield, Dr. Dugard, the Rev. I. Roche, Mr. Jones, and Dr. Lloyd, have also contributed to throw light on the structure of their respective neighbourhood in Shropshire. The last gentleman has been fortunate enough to discover the remains of *Trilobites* in the old red sandstone.

the directions of those extensive anticlinal and synclinal lines which he has determined with much personal labour, though unaided by good geographical data. It will then be shown by him at what periods igneous action has been in operation within these older rocks; whilst it will be my province to point out how these outbursts have been succeeded, on the eastern frontiers of the principality, by other linear, submarine eruptions, and to describe the effects produced by them upon the different sedimentary strata.

These results must, however, only be viewed as the first attempts, on the part of Professor Sedgwick and myself, to reduce to chronological order a vast succession of ancient deposits, which have hitherto been much neglected in this country, on account, as we may suppose, of the alleged obscurity of their organic remains, and still more, perhaps, in consequence of their altered condition, due to the numerous convulsions to which they have been subjected.

**IRELAND.**—We have been favoured with two communications upon the geological structure of parts of the north of Ireland, illustrated by excellent maps, constructed by the authors. In one of these, Mr. A. Bryce, of Belfast, describes the north-eastern portion of Antrim, in which he points out a much larger extent of mica schist than had been noticed by former observers. These primary rocks are succeeded, in ascending order, by ancient red conglomerates, partial carboniferous deposits, new red sandstone, lias, greensand, and chalk. He mentions porphyry as only associated with the older red sandstone; and basalt, as overlying the chalk, all the important peculiarities of which have been so well detailed by Conybeare and Buckland.

The other Memoir upon Ireland is from the pen of Archdeacon Verschoyle, and is much more comprehensive, describing the north-west coast of Mayo and Sligo. The accompanying map is of considerable value, the geographical features having been obtained from the Ordnance surveyors; chiefly, I believe, through the intervention of Capt. Portlock, R.E.

The Archdeacon shows that this region has for its mineralogical axis a mountainous range of mica schist, and other primary rocks, the overlying deposits consisting of partial conglomerates, succeeded by the carboniferous limestone and unproductive coal measures,—the former containing, as in many parts of England, a lower limestone shale and an oolitic limestone. In describing the rocks of intrusive character, this author is to be much commended for having traced, with precision, the course of no less than eleven basaltic dykes, within a zone of eleven miles in breadth; which are parallel to each other, trending nearly W. to E., and striking through all the rocks of the district—one of them being observable for the distance of 60 to 70 miles.

With such works as these before us, we may feel assured that the day is not far distant, when a manual of the structure of the whole of our sister kingdom may be compiled. This useful work will doubtless be achieved by the efforts of the members of the new Geological

Society of Ireland, who in the mean time will, it is hoped, extend their discoveries to Galway, and such tracts as have not been examined by Weaver, Griffiths, and other good observers.

**ROCKS OF IGNEOUS ORIGIN.**—Two of our Foreign Members have, in the past year, favoured us with communications, both of which relate to igneous action.

Signor Monticelli, of Naples, has noticed, in one of the largest and most ancient currents of Vesuvius, called La Scala, that besides the appearances of regular stratification which the lava possesses, as formerly observed by Breislac, it presents, when still more deeply cut into, a curvilinear arrangement, proving that these masses have been formed in concentric layers around an elliptical nucleus.

Professor Necker of Geneva, reviving and extending an ingenious hypothesis of Dr. Boué, has led the way in attempting to bring under a general law the relation of metalliferous veins and deposits to those crystalline rocks which, by the great majority of modern geologists, are considered to have been produced by fire.

Humboldt had indeed already expressed his belief that the mines on the flanks of the Oural, being associated with porphyritic and granitoid rocks, have resulted from former volcanic agency; and Professor Necker now cites many additional authorities, to show similar juxta-positions in other parts of the world. Whether the doctrine of sublimation, suggested by the author as the best explanation of this problem, can be sustained, is very doubtful; since the case which first led him to a contemplation of these general views,—a deposition of specular iron on the surface of a stream of Vesuvian lava, is one which, having taken place under the terrestrial atmosphere, may have been due to a cause which could scarcely have been co-existent with submarine or deeply-seated subterranean phenomena. Such difficulties, however, instead of checking, ought rather to stimulate us to pursue with vigour this animating train of inquiry, by gathering together data responding to the queries of M. Necker, and by pointing out with equal fidelity all those districts which come within the application of his theory, as well as those great metalliferous tracts, in which as yet no trace of contiguous, unstratified rock has been observed. Why are we to shrink from the supposition, that in this, as in the production of other phænomena, nature may not have employed various means, when it is known that a distinguished French chemist\*, imitating her energies, has succeeded in producing simple minerals by the direct union of their constituents. If, therefore, the ingenuity of a second Hall should demonstrate the very manner in which volcanic forces, under great pressure, may have produced effects analogous to those of sublimation beneath the common atmosphere, there are still wide fields for experiment. For who can venture to expound all the possible effects of those

\* Berthier.

changes depending upon the laws of electro-magnetism, which must have been evolved by the varied actions of the elements, brought into play during those movements by which the land and sea have changed their places?

In the mean time, the Essay of M. Necker must be regarded as an excellent stimulant to research; and judging from my own limited experience, and particularly from facts observed in the mining districts of the west of Shropshire during the last summer, I should infer, that England will not be found deficient in phænomena amply corroborative of the views of Humboldt, Boué, and Necker:—Mr. Henwood has long been engaged in an inquiry, the objects of which cannot be too much commended; and you have already heard the result of a considerable number of his most laborious investigations. It would appear from these that he has already ascertained that the phænomena of the mineral veins of Cornwall, do not come under those general laws to which they have been referred by the native miners. As, however, his labours are still in progress, it would be premature to speak of the consequences to which they point, before the whole of them are given to the public.

I am here naturally led to speak of a work upon the Geology of Cornwall, by Dr. Boase, composed of two parts, the former of which contains most instructive and valuable detail, collected with indefatigable industry, and is a most important addition to our previous knowledge of the structure of that portion of our island. The Second Part, though supported by arguments conducted with skill, and tending consistently to one leading object, is directly opposed to the opinions of nearly all modern geologists. Dr. Boase differs from previous observers, who conceived that certain granitic veins which ramify through the slates have been injected into the latter; and supposes, since many of these veins are made up of the same ingredients as the surrounding slate, that the whole is of common and contemporaneous origin, the veins being merely crystalline segregations. Now, without denying the existence of many contemporaneous and segregated veins in Cornwall as in other countries, surely no one can at this day resist the accumulated mass of evidence adduced by Allan, Sedgwick, Dechen, Oeynhausien, and a host of geologists, which indicates the posterior intrusion of such veins as branch upwards from large bodies of granite, and ramify in thin filaments through the overlying killas. If, however, granitic veins be formed by segregation, and if the masses of schist within a granite vein are but portions of that vein under a different state of development, by what happy accident, we would ask, do the angles of the entangled fragments accord with each other, or with those of the wall of the vein itself? Concretions with some approximation to regular forms, may have separated themselves chemically from mineral masses to which they are subordinate: but no mode of chemical action can offer us an intelligible explanation of the angular fragments of killas imbedded in the granite veins of Trewavas Head and other parts of Cornwall. They can be explained rationally only on the supposition of the mechanical

protrusion of the vein itself into the mass of the pre-existing slate-rock. But Dr. Boase extends the horizon of his speculations : he will not even concede that the dykes of porphyry and elvan in Cornwall afford any proofs of igneous origin or of subsequent intrusion ; and rising with his favourite hypothesis into hostility to every operation of fire, he at length avows himself sceptical as to the volcanic origin of all trappæan rocks. Whatever may be the value of the arguments applied to Cornwall, they must be seriously weakened by a mode of reasoning which compels the author to deny the existence of phænomena which may really be considered as mathematically demonstrated, and which are now registered among the fixed principles of the science. If Cornwall does not offer clear proofs of the igneous origin of any of its rocks to the eye of Dr. Boase, why does he not seek to verify or reject his theoretical inductions by an appeal to countries where the evidences are clearer? Let him visit Scotland, and inspect all those appearances of intrusive granite, which have long since been recorded by the approving testimonies of Hutton, Hall, Playfair, and Seymour ; and let him follow MacCulloch through the Hebrides, and then inform us whether he has not been led to a modification of his views. But if these evidences should not produce the expected result, I would urge him to travel into central France, where in one limited district is seen a succession of epochs of igneous intensity, from the oldest trappæan rocks to modern basaltic lavas, demonstrating that all these have originated in a succession of similar volcanic causes. Notwithstanding, however, the discrepancy between the views of Dr. Boase and those of most modern observers, I repeat that his work being the result of long-continued examination, is well worthy of your study from the valuable facts which it presents.

In the mean time, permit me to notice how the evidences of former volcanic agencies have lately been operating upon the minds of observers in distant parts of the world. In a recent work by Messrs. Jackson and Alger upon the Geology and Mineralogy of Nova Scotia, the authors acknowledge that in the commencement of their survey they were biassed in favour of the Wernerian theory ; but when they met with repeated instances of sedimentary deposits, suddenly altered and rendered crystalline, and of vegetable remains charred when in contact with trappæan rocks ; and when they also found these latter rocks possessing all the intrusive characters assigned to them in Europe,—they became satisfied of the insufficiency of the aqueous system, and upon conviction, embraced the igneous theory as affording the only satisfactory solution of such phænomena.

The student who seeks for further evidence upon this subject, may advantageously consult the Synopsis lately published by Professor Leonhardt of Heidelberg, in which many of the well-authenticated phænomena attesting the effects of igneous action have been grouped in so clear a manner as to leave no escape from the inferences upon which I have been insisting.

Colonel Sykes, after a long residence in Hindostan, has presented us with a circumstantial account of the structure of the Deccan or hilly region of the Peninsula to the east of Bombay. This tract,

it appears, is very similar to the other extremity of the vast trap region which was described by Major Franklin, being exclusively composed of trappæan rocks, which offer many varieties in mineral composition. These rocks rise in tabular forms from low terraces upon the coast, until they attain heights from 4000 to 6000 feet in the interior: the profound chasms by which they are fissured are occupied by the rivers, and their hardest and loftiest protuberances afford those strong natural defences of the natives, known to Europeans under the name of Hill Forts. In these step-like table-lands are the remnants of volcanic outbursts of successive periods, presenting further analogies to known igneous productions in dykes of columnar basalt which have been injected vertically through the horizontal currents. According to the observations of Colonel Sykes and of his precursors Capt. Dangerfield and Dr. Voysey, these igneous phænomena extend over 250,000 square miles; so that the mind is almost lost in the contemplation of their grandeur: unfortunately, the relative age of these eruptions must remain for the present undetermined, no vestiges of secondary or tertiary formations having been detected within the region described.

Although that interesting small tract of extinct volcanos the "Eifel," had been partially made known to the English reader by Dr. Daubeny and Mr. Poulett Scrope, an adequate knowledge of it could be obtained only by consulting the works of several German writers\*. Our learned associate Dr. Hibbert has now presented us with an account of the same district, under the title of "History of the Extinct Volcanoes of the Basin of Neuwied," to complete which he has devoted two years of assiduous, personal exertion. In recommending this volume to your study, I may express my regret that the author should not have first distinctly laid before us a clear view of the mineral constitution and physical features of the district, and afterwards have deduced therefrom his ingenious theoretical views;—the more so, as his inferences are interwoven with theories of the earth, which, whether in respect to parallelism and consequent synchronism of mountain-chains, or their divergence and necessary diversity of age, are still subjects of contention among leading geologists.

Dr. Hibbert has, however, done essential service in delineating the topography and true features of this disturbed region. He has further laboured hard to impress upon us a conception of those vivid images which he has established in his own mind, as the true landscapes which this district and its environs must have successively offered to view, as well in the various periods of volcanic eruption and violence, as in those of quiescence, during which lacustrine, estuary, and terrestrial accumulations were formed. In accounting for

\* While these pages are passing through the press, I learn that Professor Hoffmann, having, on his return from Sicily, studied the relations of the marble of Carrara, has communicated to the Academy at Berlin his opinion, that this marble is of the age of the oolitic series (Jura or Alpine limestone), and has been changed by igneous operations similar to those which altered the chalk of Antrim, the lias limestone of Skye, &c. &c.



the production of trachyte, which is so intimately connected with these ancient lake-craters, he has direct recourse to the analogies of modern volcanos, and also attempts the reconstruction of those more recent currents of basaltic lava, of which there are now left such imperfect evidences. If Dr. Hibbert has succeeded in proving the relative age of the outbursts of the various volcanic products of the Eifel from trachyte to the most modern basaltic ejections, he has accomplished a task from which his precursors have shrunk; their great difficulty consisting in the comparative absence or obscurity of all strata of secondary or tertiary age, which, if they contained distinct evidences in their organic remains, might have been deemed true historical records. In Auvergne and in the Cantal, where no such deficiencies exist, but where, on the contrary, the sedimentary strata have been elevated into mountain-masses teeming with the remains of organic life; the precise relative periods at which the intensity of volcanic action has been renewed, or suspended, is demonstrable by alternate dislocations and regularities of the associated strata. But in the Eifel, if we except the fossils of that very ancient group of rocks the grauwacke, the evidences to be gathered from organic remains in the subsequent epochs are deplorably deficient, being merely observable in thin patches of brown coal and tertiary clay, a few only of which are connected with the volcanic phenomena of this district.

That brown coal is associated with tertiary deposits of various ages is well known to those who have explored Germany and the flanks of the Alps; and the greater part of this mineral in the basin of the Lower Rhine has been referred to an early period in the tertiary series. This subject has recently been freed from much of its obscurity by the observations of our valued fellow-labourer Mr. Leonard Horner, on the Geology of the Environs of Bonn\*. From this very able Memoir we learn, that notwithstanding the difficulty of assigning a precise geological age to this deposit, on account of the almost entire absence of shelly remains, yet from the imbedded fishes, frogs, and plants, which though essentially differing from, bear a strong analogy to existing species, the brown coal of the Rhine is probably of the age of the lacustrine limestone of Aix en Provence.

Mr. Horner further throws new light upon the period of the trachytic and basaltic eruptions of the Sieben-gebirge, which, like many volcanic hills in central France, he supposes to have burst forth from beneath an ancient lake; and whilst he indicates that this ridge has been elevated posterior to the formation of the associated brown coal, he shows that one of the lake-craters on the opposite bank of the Rhine, the Rodderberg, was formed during a more recent period, probably contemporaneous with the accumulation of the loess or loamy alluvium.

We are here naturally led to reflect upon that exciting theoretical question concerning craters of elevation, which now divides the geo-

\* M. Mitscherlich is also, I am rejoiced to learn, now engaged in writing a Memoir upon this district.

logists of France and Germany. In France, De Beaumont, Dufrénoy, and others, contend for the establishment of the views of Von Buch and Humboldt, which refer the crateriform cavities to simple expansion of the earth's crust, caused by intumescence from within; whilst Cordier and Constant Prevost maintain that all these ancient cones and craters present in their structure a direct analogy to the products of modern volcanic agency, and have been similarly formed.

M. Constant Prevost is preparing an account of his late voyage in the Mediterranean, by which he hopes to convince us, that all the most ancient geological phenomena, of igneous characters, can alone be rationally explained by an appeal to existing evidences, thus harmonizing in his speculative views with our countryman Mr. Lyell, who, from an examination of the same districts, had before arrived at similar conclusions, and who had been among the first to combat the theory of elevation craters as applied to the Cantal and Mont D'Or\*. I must for a second time allude to the forthcoming volume of this author, in which you will find descriptions of those interesting tracts, the Eifel, and of Olot in Catalonia, coupled with an abundance of striking and original observations respecting the volcanic ejections of Etna, which absolutely demonstrate, that many of our older trappæan currents must have had a similar origin.

In concluding this review of works illustrative of volcanic phenomena, I announce with delight that our secretary Dr. Turner, in co-operation with Mr. De la Beche, has commenced a series of experiments to determine the effects of heat upon various rocks, both crystalline and sedimentary, for the purpose of elucidating the modes in which some may have been formed, and others altered. The inquiry will afterwards be extended to the production of simple minerals, and will also lead to the repetition of some of the experiments of Sir J. Hall, in a field nearly abandoned in Great Britain since his successful career, although France and Germany have to boast of the important discoveries of Berthier and of Mitscherlich.

Having adverted to those works, of the past year, which may be conveniently classed under separate scientific heads, I will now briefly allude to a few Memoirs relating to foreign countries, which possess a general character, and yet bear upon our own Proceedings.

**SPAIN AND PORTUGAL.**—We have hitherto acquired but limited knowledge of the geology of Spain and Portugal. In anticipation of further information from Colonel Silvertop, who has lately revisited the southern provinces, and a promised Memoir of Capt. Cook, R.N. we have before us the first geological sketch, which has been attempted, of the general structure of the Peninsula from the pen of Professor Hausmann, in a work entitled "*Hispaniæ de Constitutione Geognosticâ*," which, founded on the personal examination of its eloquent author, conveys a very clear idea of the simplicity of structure which characterizes a large portion of that country.

\* Principles of Geology, vol. i. p. 386, &c.

Mr. D. Sharpe has read before this Society an account of parts of Portugal. He acquaints us that the rocks around Oporto consist of granite succeeded by gneiss and mica schist, which are overlaid by conglomerates containing anthracite, and by blue clay. Between Oporto and Lisbon he points out trappæan rocks and an ancient secondary sandstone overlaid by a limestone with belemnites. The estuary of the Tagus is stated to exhibit on its shores a tertiary series separable into three divisions. The lowest of these is a fossiliferous blue clay; the intermediate and most extensive group is made up of sand and arenaceous limestone, which, judging from their fossil contents, are probably of the Sub-Apennine age. Organic remains have not yet been observed in the uppermost group, although we may incline to the belief, that in a country so convulsed by earthquakes within the term of history, these superficial beds of sand may prove of the same age as the youngest shelly deposits which have been raised upon the shores of the Mediterranean Sea.

BRITISH COLONIES.—I expressed, on a former occasion, the hope that our East Indian possessions might soon be rendered more interesting to us by an exposition of their geological relations, and particularly by descriptions of the carbonaceous and other deposits of the Peninsula. We have in the mean time received an account of the structure of Pulo Pinang, and its adjacent islets, drawn up by Dr. Ward, an able and zealous naturalist, at the suggestion of the East India Company's Resident, Mr. Kenneth Murchison. Although we may regret that the Malayan Archipelago offers no other than primary rocks, here and there covered with their disintegrated materials, we must hold up as highly worthy of imitation that good spirit which prompted the Resident to take all the means at his disposal to obtain for us this amount of natural knowledge; as it is obvious, that similar efforts on the part of the chief officers in our numerous distant colonies would prove of inappreciable value. And here I would point your attention to the short "Instructions for Young Geologists," which were prepared for distribution in the colonies; and I would request you in circulating these Instructions, to urge upon your friends in the West Indies the real service they may perform by sending home suites of specimens, to afford us the means of instituting a comparison between the silicified zoophytes of those parts, and the existing corals of the adjoining seas.

CONTINENTAL WRITERS.—The Discourse of the President of this Society must, from its brevity, be chiefly devoted to the review of the discoveries and proceedings of the English school; for so numerous are the European observers, that a volume would scarcely suffice to elucidate their annual productions. In this place, therefore, I can simply allude to a few of those writings which, from their comprehensive nature, will best acquaint you with the recent pursuits of our coadjutors in various parts of the continent.

M. Boué, in his "*Considérations générales sur la Nature et l'Origine des Terrains de l'Europe*," brings into discussion every great general and theoretical question, with reference to the origin of each

formation, in the tone which peculiarly marks the present development of the science. To the enlightened Reports of the Geological Society of France, by the same learned author, I have made honourable allusion on a former occasion; and I have now to notice the last Report upon the progress of geology in France, by M. Desnoyers, where the subjects that have occupied geologists are treated of under distinct heads, in each of which the various matters are synthetically grouped, their connexion clearly pointed out, and their cumulative bearing on the science admirably stated. In short, this Report of M. Desnoyers is conclusive evidence of the advantages which have already flowed from the establishment of the Geological Society of France, in giving a full view of the practical labours of all the geologists of that country, whose works without such an organ of communication would not have been understood or duly appreciated by the scientific world.

The unabated vigour of research which animates the geologists of Prussia, is the natural effect of the examples of Humboldt and Von Buch. Although your attention has already been drawn to several individuals of this nation, whose discoveries had reference to the topics contained in this address, a work of deep utility still remains unnoticed, in the German translation of the Manual of Mr. De la Beche, by M. Von Dechen, who in thus communicating to his countrymen the essence of the practical geology of England, with which he is so thoroughly acquainted, has further transfused through this volume all the spirit and knowledge of the modern school of Germany.

It is deeply to be regretted, that England is so ill supplied with information of the proceedings of the geologists of Italy. In announcing that we may soon look for the appearance of a map of the southern flanks of the Alps, embracing all the sub-alpine regions, delineated by three such competent geologists as the Marquis Pareto of Genoa, M. Cristoforis of Milan, and M. Pasini of Schio, I may briefly remind you, that the land which was the cradle of geology, still contains within it men endowed with the intelligence and enterprise requisite to complete those illustrations, which are essential accompaniments of the present condition of the science\*.

\* I have abstained, on this occasion, from noticing a recent Memoir of M. Pasini, in which, supporting the theory of the Count Marzari Pencati, and opposing the views of Von Buch, Boué, De Beaumont, and others, who contend for the elevation of the secondary limestone of the Alps, he controverts a sketch of my own upon the "*Relations of the Tertiary to the Secondary Rocks in the neighbourhood of Bassano.*"—(Phil. Mag. and Ann. vol. lv. June 1829.) At some future day I may point out the extent to which M. Pasini has misunderstood the facts I have explained; probably from his rigorous interpretation of a hastily drawn section. This slight sketch was simply intended to show, that within a *very limited* district on the southern flank of the Alps, the tertiary strata were highly inclined in conformity with the scaglia or chalk, as clearly exhibited in the bed of the Brenta. Of the dolomite of that region, it was not my intention to have spoken; and I regret that the few words relating to the disrupted masses of that rock in the defiles of the Brenta should have been thought worthy of so much criticism on the part of the ingenious author.

UNITED STATES.—Though this be not the occasion on which I may dilate upon the productions and discoveries of our foreign contemporaries in Germany, Italy, and France, still I may offer a few brief remarks on the strides which have been recently made by our coadjutors in the Western hemisphere, connected as they are with us by community of origin and language.

In the United States of America our science, cultivated upon true principles, rises steadily in public estimation. A Geological Society is formed at Philadelphia, which commencing energetically in the collection of specimens, and inviting descriptive sections from all parts of Pennsylvania, shows how effectually the intelligence and public spirit of this State have been drawn to our subject,—an effect chiefly due to the writings and lectures of our zealous Associate, Mr. Featherstonhaugh.

Another of our Fellows, Mr. R. C. Taylor, has begun to apply his acquaintance with English geology, in describing a large bituminous coal-field on the flank of the Alleghany Mountains, which seems to bear a striking resemblance to the carboniferous districts of Great Britain.

To Dr. Haerlam, already known by his valuable contributions to the works of Cuvier, we owe several important recent additions to fossil zoology.

Dr. Morton, Corresponding Secretary of the Academy of Sciences of Philadelphia, who had illustrated the organic remains of the ferruginous sandstone of Pennsylvania, has also formed an instructive and rich collection of the tertiary shells of that State, which have met with an excellent expositor in Mr. Conrad. The First Number of a work, long desired by every European geologist, has just appeared, entitled “Fossil Shells of the Tertiary Formations of North America,” by this author; and I may confidently recommend it as a most instructive performance, the continuation of which will at length enable us to speculate with confidence upon one important class of the deposits of that vast continent. Some inaccuracies of comparison seem to be owing to the author’s unacquaintance with those conchological distinctions which have been so very recently applied to the tertiary groups by Desnoyers, Lyell, and Deshayes. Without entering upon the nature of the vast alluvial and diluvial accumulations of North America, which upon minute and careful examination will probably be found to offer all the subdivisions they are capable of in Europe, I must remark, that in the triple classification of the tertiary formations, the author errs in supposing that the shells of our crag, which he identifies with his upper marine, are all of existing species; it being ascertained that the crag contains only about 45 per cent. of shells identical with those now living.

Nor can the middle tertiary formation of Mr. Conrad be positively identified with the “calcaire grossier,” until we are supplied with lists of the relative numbers of the existing and extinct species. The lower tertiary formation, it is evident, cannot be classed with the “argile plastique” of M. Brongniart, upon the test of lignite alone; since that substance is no longer deemed characteristic of one particular pe-

riod, but occurs in tertiary groups of all ages: in truth, the plastic clay occupies no longer a place in the list of European formations, being simply the occasional substratum of certain tertiary basins, in many of which it is inseparable from the overlying clay. These errors of comparison and geological classification are, however, quite excusable on the part of a naturalist, who strives to arrange his subject after models he has been taught to consider classical, but which inevitably have partaken of such defects as characterize the broad generalizations of the early geologists of all countries. Such defects are, however, of little moment, and can soon be obviated. The high merits of the undertaking of Mr. Conrad are to be found in an accurate delineation of the organic remains, and in his faithful account of the manner in which the strata containing them have succeeded to each other. By his description we now learn, for the first time, that the whole line of coast of North America has been elevated after the creation of existing mollusca, and that the highest or youngest of these fossil groups is spread over a zone of land of 150 miles in breadth! Judging from the information before us in the first fasciculus of this interesting work, it may be inferred that these upper shelly sands and marls are synchronous with those modern elevated groups in the Mediterranean, by some geologists termed Quaternary, which Mr. Lyell classes in the group of newer Pliocene. I have now to express my hope that Mr. Conrad may meet with such encouragement, that he may complete not only the illustration of these younger and tertiary shells, but succeed also in his laudable ambition of describing the remains of the secondary and older formations of North America.

That geology is pursued with vigour in other States of the Union, we have abundant proof in the Journal of Professor Silliman.

Professor Hitchcock has published a well-digested and circumstantial Report upon the Mineral Structure of Massachusetts, accompanied by an illustrative map. That part of the work which shows the value of an acquaintance with mineral masses in their application to the agriculture and commerce of the state, has alone appeared; but the materials, therein collected, bear testimony to so much ability and research, that some good geological induction may be looked for in the second volume.

This author will, however, pardon me if I suggest some caution in the identification of those great tracts of red sandstone in America with the *new* red sandstone of England; since it is obvious that in countries where the coal measures are wanting, it is difficult to arrive at safe conclusions. We now begin to perceive, that even in England strata of similar red colours reappear at intervals throughout the descending order, from the base of the lias to vast depths within the grauwacke series. Still less is a red sandstone to be identified with the new red sandstone by the presence of salt; since it is now demonstrated that this substance occurs in formations of all ages, from the youngest tertiary to the oldest transition rocks.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—We may now revert to the consideration of the general state of our native

geology. Connected, as our progress must be, with the advancement of other branches of science, I am sure you will unite with me in rejoicing that so much success attended the second assembly of the British Association, held last year at Oxford. The cordial reception its Members met with from that distinguished University, has been the means of making known its objects, and advancing its interests; and its continued success is secured by the invitation of the sister University to hold the ensuing meeting at Cambridge.

A volume about to appear, containing the original Reports read at Oxford, will sustain the high reputation of their respective authors; and the cultivators of our science will gladly see that the recent progress and present state of geology found an able and eloquent expositor in our Vice-President Mr. Conybeare.

I would further request your attention to the numerous important queries, suggested by the Geological Committee of this body, which will explain how intimately its objects are connected with our own. If, indeed, it be essential to our progress to secure the zealous co-operation of our friends in other departments of science, where can we so well make known our wants, where can we better gather data for the extension of our inquiries, or where find so good a solution of our difficulties, as in a general Congress, which embodies men of distinction from all parts of the British Isles?

But to you, Gentlemen, it is needless to expatiate on such obvious advantages; for already by your hearty cooperation you have striven to uphold the merits of the British Association for the Advancement of Science. So highly indeed have these efforts been valued, that this great Institution has done honour to us, in selecting for their last and their succeeding Presidents the geological leader of each University,—men already enshrined in the hearts of all whom I now address.

**GEOLOGICAL DESIDERATA.**—The amount of geological labours performed in Great Britain within the past year, indicates, I hope, a continuance of exertion as vigorous as that of any former year; but notwithstanding the good ends which have been realized, I feel that there still remains a duty for me to perform before I quit this chair, by placing before you a few of the essential desiderata at home, which must be supplied before we shall have completed the sketch of the geological structure of the whole kingdom.

Much as has been written upon parts of Scotland, no comprehensive work has yet appeared in the English language descriptive of the whole of that country; although Dr. Boué and Professor Necker have long since explained to their countrymen the general relations of its rocks. It must be granted that the northern portion of Scotland has received more than its fair proportion of attention; for besides the eminent geologists of the school of Hutton, who sought in it for the proofs of the truth of the theory of their master, the crystalline and trappæan rocks of those parts have met with ample and able commentators in Jameson, Allan, Mackenzie, Hibbert, MacCulloch, and other living authors; the nature of its sedimentary deposits

has been partly recorded in your Transactions by Professor Sedgwick and myself. In the central and southern division of Scotland, however, and in the coal-fields particularly, we yet require many descriptions of large tracts, and some general work, which, embracing all the country between the borders of England and the rise of the Grampian chain, shall inform us whether the regular coal-measures are based upon mountain limestone, or descend, as it is stated they do, in northern Northumberland and in Berwickshire, into the old red sandstone.

The Reverend Dr. Fleming has, I learn, obtained a clear knowledge of the complicated and disturbed coal-field of Fifeshire, and has extended his researches to the south-eastern flanks of the Grampians: we may, therefore, look with confidence to the result of his observations, while we express our wishes that this able naturalist may further have it in his power to describe the relations of the great trappæan range of the Ochills.

If, however, we are led to anticipate some correct views of the northern edges of this great vale, we shall still be strikingly deficient in data concerning its southern division. Although Nithsdale has been described by Mr. Monteith, the older chain of the Lead Hills, and all the surrounding groups of the transition series, still require much detailed examination. Let us, therefore, hope that Professor Jameson, who has laboured to such good effect in the department of the unstratified and trappæan rocks, may, by his own efforts, and those of his pupils, fill up these blanks in the secondary geology of his native country.

It is not, however, on the north side of the Tweed alone that deficiencies exist. The English side of the Scottish border calls equally for exploration; since we are still without any good account of the porphyritic ridges of the Cheviots, although we may, I believe, expect one from the pen of Mr. Culley.

In England and Wales the difficulties attending the development of the oldest sedimentary formations are, as you have seen, fast vanishing; thanks to Professor Sedgwick, who, having fairly grappled with this obscure yet indispensable branch of our subject, will shortly lay before you the final results of many years of anxious labour. I have endeavoured to extend, in the ascending order, these labours of my friend, into the younger and more fossiliferous tracts upon the borders of Wales,—to point out the formations into which they are divided,—and to connect these with the old red sandstone and overlying deposits. To the termination of this work I look with pleasure in the ensuing summer.

If we turn from these hitherto neglected western regions and transport ourselves to the eastern shores, who does not perceive that we are there without any complete history of the crag and younger deposits? The works of Mr. R. C. Taylor and others, though excellent in their respective districts, are not of general application; and ingenious as are the views of Professor Lyell, they are only drawn from those parts of the coast which have fallen under his own observation.

Let me, therefore, entreat you to wipe away this imperfection from



our system, and to endeavour to establish demarcations as clear as our fellow-labourers in France have done for the deposits of this age, by working out the whole extent of the crag, and the precise nature of its upper limits : also by showing the relative ages of gravel beds with existing species of shells, and the numerous lacustrine and terrestrial accumulations which abound along our east coast, from the north bank of the Humber to the mouth of the Thames.

The most essential, however, of all our scientific wants is a perfect history of the coal-fields ; for, connected as these are with the existence of England as a manufacturing nation, the call for information upon this point cannot be too frequently repeated, nor its importance too warmly inculcated.

Some addition to our knowledge of carboniferous tracts has recently been made by that excellent geologist Mr. J. Phillips, in a short Memoir upon the Ganister, or Lower Coal-field of Yorkshire, a full account of which will shortly appear in the Second Volume on the Geology of that county\*.

I hope soon to lay before you a succinct view of those undescribed and thin fields of coal in Shropshire, which have been accumulated in ancient bays, covering the edges of the grauwacke formations, or resting upon the old red sandstone and mountain limestone. As these fields are carried under the great trough of northern Salop and Cheshire, may we not reasonably infer, that at some future day a vast emporium of deeply seated coal may be discovered and worked beneath the new red sandstone of that district ?

But to how many other parts of this island may we not apply similar speculations ? How many and how vast are these carboniferous fields, with the true details of which we are entirely unacquainted ?

If, Gentlemen, I specially invoke your continued exertions in *this* department, it should be borne in mind that the results must essentially benefit our fellow-creatures ; and I am therefore confident that the time is come, when, duly estimating our labours, the whole country will proclaim, that “ *Geology is a pursuit of the deepest national importance.*” With this feeling it is that our lists are already adorned with some of the most honoured names in the land ; and the only boon which we demand in return for our gratuitous efforts is, that the landed proprietors of England will enrich our archives with sections and illustrations of their several neighbourhoods.

In thus adverting to the practical uses of geology, and in asserting that our advances have been firmly secured, by patiently working out the evidences offered by the fossil world ; we must at the same time allow, that our progress has been occasionally checked by the promulgation of captivating but untenable theories.

Persuaded as we are that there is no royal road to the truths we are in search of, let us guard against hastily conceived speculations,

\* I am informed that Mr. E. Hall, of Manchester, has made an addition to our local carboniferous geology, by the completion of a MS. map of South Lancashire coal tract.

which none can form more readily than those who have least laboured in our vocation ; recollecting that theories are only to be tolerated so far as they accord with Nature's laws and positive observations.

Let us not cease to weed out from the school of English geology the schemes of those who would seek to grasp the conclusion of the problem before the very data have been fully placed before them. Acting on the maxims of the great father of modern philosophy, and proceeding steadily from the known to the unknown, let us not be appalled by the magnitude of the difficulties we have yet to vanquish,—but let each of us strive to bring annually to these halls, fruits earned by the sweat of his brow ; conscious, if any laurels be decreed by posterity to the geologists of this age, that those will have the largest share, who by their own discoveries have best contributed to lay the true foundations of the science.

In a science like our own, receiving the perpetual accession of new discoveries which limit or extend our previous conclusions, it is obvious that few geological memoirs can be perfect, when they first proceed from the author's pen, however experienced in observation. The ordeal, therefore, our writings have to pass through in the animating discussions which they elicit within these walls, may be considered the true safeguard of our scientific reputation. This excellent practice, sanctioned by long experience and your approval, not only ameliorates your transactions, by calling forth and embodying the unrestrained opinions of practised observers ; but it further operates in cementing us into a community of good feeling, and gives to our assemblies that stamp of energy and friendship which has long characterized this Society.

The term of my services, Gentlemen, is now expired ; and I bid you farewell, with heartfelt thanks for the countless proofs of kind cooperation you have given me, and which, more than I can express, have bound me to your interests and welfare. My gratification is this day complete, in having to record, that among the numerous acts of which you may be proud, there is no one more creditable to your feelings, or better devised to consolidate the prosperity of this Institution, than the last expression of your will, by which you have transferred the power from my hands to those of one, whose life has been devoted to your cause, and who may justly glory in having been the first President of the Geological Society of London.

# PROCEEDINGS

## OF

### THE GEOLOGICAL SOCIETY OF LONDON.

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1833.

No. 31.

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February 27.—William Henry Booth, Esq., of Old Square, Lincoln's Inn; and Channing Pearce, Esq., of Bradford, Wilts; were elected Fellows of this Society.

A paper, commenced during the last Session, entitled "Description of Parts of the Kingdoms of Valencia, Murcia, and Granada, in the South of Spain," by Capt. Cook, R.N. F.G.S., was concluded.

The district described in this memoir is stated to comprise the mountainous country which intervenes between the southern boundary of the plains of La Mancha and the Mediterranean. The formations of which it is composed are divided by the author into primary, secondary, tertiary, and volcanic.

The primary rocks are said to consist chiefly of granite, mica-slate, and clay-slate, with occasional beds of limestone, talcose and chlorite slate, and serpentine. These primary formations constitute the mountain ranges of the Sierra Morena, Sierra Nevada, Sierra Filabres, the Lomo de Vaca, and some minor hills near Velez Malaga, the river Almazora, and the valley of Almazarron.

The secondary deposits are stated to consist almost entirely of compact, dolomitic limestone, generally destitute of organic remains, and resting on the primary slates; but on the flank of the Sierra Morena, and in the neighbourhood of Granada, a red sandstone is said to be interposed between the limestone and the older formations. The principal districts composed of this limestone are the hills which range between the plains of La Mancha and the Mediterranean, the Sierra de Segura, the Sierra de Gador, celebrated for its lead mines, and the rock of Gibraltar.

The tertiary formations are stated to consist chiefly of conglomerates, sand, marl with gypsum and salt, and coarse friable limestone, containing organic remains. They are said to form low hills, and to occupy the plains and the valleys, surrounded by the ridges of secondary limestone. The principal localities, mentioned by the author, are the plains of Valencia, Alicante, Murcia, Carthagena, Aguilas, and Granada; the valleys of the Segura, Lorca, Almeida, and the Guadalquivir. Allusion is also made to the basins of Baza and Alhama, described by Col. Silvertop in a memoir laid before the Society during a former Session.

The igneous or volcanic rocks are but briefly noticed: the localities cited are Almazarron and Cape de Gata.

A paper entitled "Observations relative to the Structure and Origin of the Diamond," by Sir David Brewster, K.C.H. LL.D. F.G.S. &c., was then read.

In the year 1820, the author communicated to the Royal Society of Edinburgh a singular fact relative to the structure of the diamond, accompanied with some conjectures respecting the origin of this remarkable gem:—the present essay may be viewed as a continuation and extension of the same inquiry.

The author refers to the remark of Newton, that amber and the diamond have a refractive power three times greater in respect of their densities than several other substances; and he quotes Newton's conjecture, founded on that remark, of the diamond being probably, like amber, an unctuous substance coagulated. In proof of the intimate relation between the inflammability and absolute refractive power of bodies, Sir D. Brewster adds the facts, that sulphur and phosphorus exceed even the diamond in absolute power of refraction, and that these three inflammables stand before all solid and fluid substances in their absolute action upon light.

Another close analogy between the diamond and amber, independently of their like locality and carbonaceous nature, was traced by the author in their polarizing structure. Both of these minerals contain within their substance small cells or cavities, filled with air, the expansive force of which has communicated a polarizing structure to the parts in immediate contact with the air. The description of this structure, which is displayed from sectors of polarized light encircling the globule of air, is illustrated by drawings.

The author contends that the peculiar polarizing power around the cavities in amber and in the diamond must have been occasioned by the expansive force of the confined substance, supposed to be gaseous, compressing the sides of the cells, while the substance of the minerals was in a soft and yielding condition. A similar structure may be produced in glass, or in gelatinous masses, by a compressing force, propagated circularly from a point.

Having thus shown that the diamond was at one time in a soft or pasty state, the author argues that this state was not produced by igneous fusion. For in his laborious examination of the cavities in crystals, both natural and artificial, such as topaz, quartz, amethyst, chrysoberyl, &c., and in salts, he observed the condition of many thousand cavities; but in no case, neither in crystals formed by means of igneous fusion nor by aqueous solution, did he observe a single cavity in which the expansible fluid within had communicated a polarizing structure, similar to that around the cavities in the diamond. He believes, therefore, that the softness must have been that of semi-indurated gum; and that the diamond was derived from the decomposition of vegetable matter, as is admitted to have been the case with amber. The crystallized condition of the diamond is not to be considered as decisive against this inference, since the mineral called mellite has a distinct crystallized form, while its composition and locality attest a vegetable origin.

A notice "On the Occurrence of the Bones of Animals in a

Coal-mine in Styria," by Professor Anker, of Joanneum in Grätz, was then read.

The bones referred to by the author, were found in a range of hills near Gratz in Styria, extending in a southerly direction from the foot of the Schwamberg mountains to Scheineck on the Weiss. These hills consist of molasse, alternating with beds of brown coal from 2 to 2½ feet in thickness, which closely resembles black coal in appearance, and can be distinguished from it only by geological position, and by the occasional occurrence of the woody texture. Associated with the coal are beds of bituminous shale, and a grey, bituminous, marly, slaty sandstone, in which are occasionally interspersed pebbles of primary rocks.

The bones were found in the coal itself, in layers from 2 to 2½ inches thick. They were for the most part so much shattered, that no notion could be formed of the genus of animal to which they belonged; but from their great number, they appear to have been derived from many different animals; and after long-continued search a jaw-bone with teeth was discovered. This specimen is preserved at Joanneum; but from the inspection of a drawing of it sent with this notice, Mr. Clift considers that it belonged to a hyæna.

Bones were first found in this mine in the year 1826, in the Joseph adit, 50 fathoms from its mouth. They have been often met with since that period in the same adit; and in 1831 bones were also discovered in the Caroline adit of the same mine, 3 fathoms to the south of the former. Among them was a tooth like that of a shark, together with fragments of bones similar to those from the Joseph adit; but they were principally found in the strata adjacent to the coal.

March 13.—James Harfield, Esq., of Queen-square Place, Westminster; and the Rev. William Otter, Principal of King's College, London; were elected Fellows of this Society.

A paper, entitled "Geology of the Environs of Bonn," by Leonard Horner, Esq. F.G.S. F.R.S. &c., was read.

The district described by the author lies on both sides of the Rhine,—the Siebengebirge, or Seven Mountains, constitute the chief feature; and the highest point in the group, the Oelberg, is 1369 English feet above the level of the sea. It possesses peculiar interest to the geologists of England, as being the nearest point where volcanic phenomena, approaching in character to those of modern times, can be seen.

The lowest stratified rock is grauwacke, which seems to belong to the later ages of that deposit, and to approach in character, in some parts of the district, to the old red sandstone. There are no associated beds of limestone. The strata are in general highly inclined, but they are found at all angles; and there is neither uniformity in the strike nor in the dip; the strike is most usually N.E. and S.W., the dip more frequently S. than N. In the immediate neighbourhood of the Siebengebirge, the strata are thrown up in all directions, evidently by the eruption of the volcanic matter.

The whole of the later secondary series is wanting, and the

grauwacke strata are covered, unconformably, by a tertiary deposit, consisting of beds of sand, sandstone, clays, and lignites, which collectively constitute a brown coal formation. This is covered by an extensive bed of gravel, and above the gravel is a loosely coherent, sandy loam, containing land shells of existing species, and called in the Rhine valley, *Loess*. From under the grauwacke there have burst forth a variety of unstratified rocks, consisting of various modifications of trachyte, trachytic tuff, basalt, and other modifications of trap. The main body of the Siebengebirge is composed of these volcanic rocks.

There are many varieties of the trachyte, from a highly crystalline rock, with separate crystals of felspar of great size, very like a large-grained granite, to a compact stone of uniform structure, like compact felspar or phonolite. The trachytic tuff also assumes various appearances, from that of a coarse conglomerate to a white earthy substance, scarcely distinguishable from chalk. There is no evidence of the trachyte having flowed in a stream, and the author saw it only in one place in the form of a dyke. There are several varieties of trap, but the most common is a compact black basalt, in many places in perfect columns. There are numerous dykes of basalt. A remarkable eruption of trap tuff, penetrated by basaltic dykes, occurs at Siegburg, where three cones, of about 200 feet in height, rise abruptly in the midst of an alluvial plain, nearly on a level with the Rhine.

The author points out the affinity which Von Buch has shown to exist between the mineral composition of all the unstratified rocks, and how a series of insensible gradations could be formed, through trachyte and the trap family, from granite to modern lava. He shows that a suite of specimens could be collected in the Siebengebirge, passing insensibly from large-grained white trachyte to compact black basalt; and that these hills afford many interesting facts corroborative of the opinion advanced by M. Gustave Rose respecting the identity of hornblende and augite. Notwithstanding, however, this connexion between the several volcanic rocks, the author points out distinct evidence of different epochs of formation among them. He is of opinion that the greater part of the trachytic tuff was the first ejected; that it was similar to those showers of scorïæ and ashes which frequently precede the eruptions of streams of lava; and that it is not, as some previous writers have supposed, a rock recomposed from the disintegration of pre-existing trachyte. He saw the trachytic tuff traversed in one place by a dyke of trachyte, and it contains numerous balls, like volcanic bombs, of varieties of trachyte, quite distinct in character from any found *en masse*. It is traversed in many places by trap dykes; and as these last are also found traversing solid trachyte, the subsequent eruption of the trap is demonstrated. He discovered no instance of the recurrence of trachyte after basalt had begun to flow. There is on the side of the Rhine, opposite to the Siebengebirge, an extinct volcano, of comparatively modern date, the Rodderberg, composed of cinders and scorified rocks. The crater is about a quarter of a mile in diameter, and a hundred feet

deep : a farm-house, surrounded by corn-fields, stands in the middle of it.

The brown coal formation is composed of beds of loose sand, sandstone, and compact siliceous conglomerate, which often, in mineral structure, cannot be distinguished from many varieties of grauwacke ; of clay, abounding with balls and layers of clay ironstone ; and of many varieties of lignite, from the state of a light brown earth, to a black compact shining mass, or jet. All of these are frequently met with in thick beds, and the lignite is most extensively worked for fuel. They contain numerous impressions of leaves, and stems of trees are very abundant. With the exception of casts of *Lymnæa* and *Planorbis*, in an opake white chert, of very limited extent, no shells, fresh-water or marine, nor any remains of mammalia or birds, have been found in any part of the formation ; but in some beds of the lignite, impressions of fresh-water fishes, the *Leuciscus papyraceus* of Agassiz, are found in great abundance, and there have also been found extinct species of frog, salamander, and triton, together with remains of insects, which Professor Goldfuss considers to belong to the genera *Lucanus*, *Cerambyx*, *Anthrax*, *Cantharis*, and eight others.

The author submitted the specimens which contain impressions of leaves, to the examination of Professor Lindley. Most of them are in too imperfect a state to admit of any accurate determination, but they consist generally of casts of portions of dicotyledonous leaves ; and among them are two species, the existence of which is sufficient to determine the relative age of the formation, and, with great probability, the then warm climate of the North of Germany, viz. *Cinnamomum dulce* and *Podocarpus Macrophylla* : there are besides impressions of leaves very clearly belonging to the Palm. It is remarkable, however, that a recent examination by Professor Nöggerath of Bonn, and M. Cotta of Heidelberg, of an extensive suite of the woods found in this brown coal formation, did not disclose a single instance of a monocotyledonous tree.

A vast deposit of gravel, chiefly composed of quartz, but containing also a few fragments of basalt, trachyte, transition limestone, and *bunter sandstein*, lies over the brown coal formation, sometimes being only a thin covering, at others attaining a thickness of 125 feet. It is very distinct in character from the gravel now forming the bed of the Rhine, and is older than some of the volcanic eruptions, for a patch of it rests on the edge of the crater of the Rodderberg, covered by volcanic ashes.

The author next proceeds to point out what he considers the relative age of this brown coal formation, a task extremely difficult, from the almost total absence of shells, and the imperfect state of the means of determining an epoch of formation by fossil plants. By previous writers it has been assigned to the plastic clay of the Paris basin ; but it appears to the author to possess no other character of identity than the mineral composition of some of the beds, and the occurrence of lignite, which prove nothing as to age. The amphibious animal remains resemble those of the great fresh-water deposit of Cœningen ; but the few shells which occur, and the plants, are

identical in species with many of those occurring in the older fresh-water beds of Aix in Provence. It seems to be very clear, that it is an exclusively lacustrine deposit, and the organic remains, the only evidence of age to be relied on where there is none from superposition of other beds, imperfect as they are, would seem to indicate a more modern date than the plastic clay. The author states that a distinguished geologist of Bonn has expressed his belief that it is even older than the chalk; but that although the opinions of that experienced observer are entitled to great respect, he cannot reconcile the phenomena described with anything known respecting the secondary rocks.

The determination of the age of this brown coal formation is of the highest importance, as fixing the periods of eruption of the extinct volcanos of the Lower Rhine; for the author of this paper shows, that the trachytic tuff contains leaves of plants identical with those found in the clay and sandstone deposits; that extensive layers of trachytic tuff are interstratified with the beds of the formation in many places; and that in one situation a mass of basalt, thirty feet thick, lies upon beds of coal thirteen feet in thickness. The conclusions which the facts appear to the author to justify, are, that there existed a vast fresh-water lake, in which the brown coal beds were deposited; that *during* that deposition volcanos burst forth at the bottom of the lake, as they do now at the bottom of the sea; and that a continuance of volcanic action, or of elevatory force, raised the Siebengebirge after the deposit had ceased,—perhaps at the very time when the basalt or trap eruptions took place, since near the summit of the Mandenberg, a columnar basaltic cone, there is a patch of brown coal beds at the height of nine hundred feet above the surface of the Rhine.

The last great formation, if it may be so termed, of this district, lying *upon* the gravel in which the present bed of the Rhine is cut, is that most remarkable deposit the *Loess*, a friable sandy loam, full of existing species of land shells, without river shells, and without plants, but containing bones of the *Elephas primigenius* and *Rhinoceros tichorinus*. It is found in detached masses, of vast thickness, but without any signs of stratification, and sometimes at a height of 600 feet above the Rhine, and may be traced with scarcely any interruption from Bonn to Basle, a distance of 250 miles. The author states that all the facts yet observed with respect to it, lead him to conjecture that its origin may have been owing to the sudden bursting of an extensive lake situated somewhere between Constance and Basle, and that subsequent denuding causes have carried away the enormous mass of matter deposited by this sea of mud, leaving only detached portions as monuments of the passing of the mighty torrent.

March 27.—Robert Williams, jun. Esq., was elected a Fellow.

The first part of a memoir “On the sedimentary deposits which occupy the western parts of Shropshire and Herefordshire, and are prolonged from N.E. to S.W., through Radnor, Brecknock, and Caermarthenshires, with descriptions of the accompanying rocks of intrusive or igneous characters,” by Roderick Impey Murchison, Esq. F.G.S. F.R.S. &c., was read.



After advertg to the want of definite knowledge of the order of succession, and of the fossiliferous characters of those great deposits anterior to the old red sandstone, and commonly called transition rocks (fossiliferous grauwacke, De la Beche), the author states that the task of attempting to separate them into distinct formations, was first suggested to him by the very clear and perfect exhibition of their details in the country under review.

The present work has already occupied large portions of the two last summers, and has for its basis the maps of the Ordnance survey, coloured geologically by the author. To the Master General of the Ordnance, to Col. Colby, Capt. Robe, and the Officers of His Majesty's Map-office, for their assistance in supplying him with good geographical data, and also to Mr. Budgin, one of the Field-Surveyors of the Ordnance, the author acknowledges his obligations. He next adverts to the unpublished yet valuable observations of Mr. Arthur Aikin, made many years ago in the north-eastern portion of the country described; and he further expresses his sincere thanks to many resident gentlemen who assisted him in his observations.

The memoir is divided into three parts. The first contains an account of the overlying deposits of new red sandstone, coal measures, mountain limestone, and old red sandstone, each of which is in contact with, or contiguous to, the transition rocks (grauwacke series) in some portion of the region described. The second and most extensive part explains the subdivisions and relations of the grauwacke series as exhibited within a zone of country extending from the Wrekin near Shrewsbury on the N.E., to the mouth of the Towey, near Caermarthen, on the S.W.; and the third part is to be devoted chiefly to the consideration of the rocks of intrusive or igneous characters, and their effects upon the associated strata.

Part I. On the New Red Sandstone, Coal Measures, Mountain Limestone, and Old Red Sandstone.

1. *New red sandstone*.—This is the youngest secondary formation in contact with the transition rocks, and is exhibited on both sides of the Severn, near Shrewsbury, being superposed to coal measures, to various members of the grauwacke series, and to trap rocks of different characters, in all of which situations it is undisturbed.

The oldest strata of this formation are compared with the *rothetodte-liegende* of Germany, or the older new red of the North of England, and are shown to underlie a dolomitic conglomerate at Alberbury and Cardeston. The superior members on the north bank of the Severn, consist of fine-grained sandstones, for the most part red, but offering at Grinshill, 7 miles N.E. of Shrewsbury, a subordinate, white building-stone, of excellent quality. Small quantities of the ores of copper and cobalt, are mentioned as occurring in the formation near Grinshill and Hawkstone, &c. Much sulphate of barytes and decomposed pyrites are diffused through the mass of these rocks. No organic remains have yet been discovered in them.

2. *Coal Measures*. a. *Coal field of Coalbrookdale*.—This coal-field is stated to rest at Steeraways and near Little Wenlock, on a thin band of limestone, which, from its fossils, is shown to be true moun-

tain limestone; whilst in the contiguous extension of this field, the carboniferous strata overlie, *unconformably*, various members of the grauwacke series, with one of which, the transition limestone of Wenlock Edge, they are brought into *conformable* apposition at Lincoln Hill, on the Severn. The complicated relations of the deposits within this small and disturbed district, east of the Wrekin, are referred to the protrusion of basalt and green-stone, which occasionally tilt the strata at high angles, and sometimes occupy the seats of faults.

*b. Coal-fields in the immediate vicinity of Shrewsbury.*—Of these, the most important is a curvilinear zone extending from the north-eastern flank of the Brythin Hills to Wellbatch, near Shrewsbury, the carboniferous strata reposing on the inclined edges of the grauwacke rocks, and dipping towards a common centre beneath the new red sandstone. Detached portions of the same zone are again found at Sutton and at Uffington; and they also follow the sinuous outline of grauwacke on the northern flanks of the Longmynd and Caer Caradoc. At Pitchford, the whole carboniferous series is represented by a bituminous breccia of a few feet in thickness.

Three thin beds of coal are, for the most part, observable, and the deposit is distinguished by an included band of limestone, similar in mineral aspect to the lacustrine limestones of Central France, and containing minute shells referrible to *freshwater* genera. The vegetable remains of the associated shales are chiefly analogous to the plants of other coal-basins; but those of Le Botwood are rich in the new species, *Neuropteris cordata*, whilst the shale of Pontesbury has offered a beautiful example of *Pecopteris blechnoides* in fructification.

After demonstrating the slight commercial value which can be attached to the thin deposits of this age, the author speculates on the probable importance of the outer zone or Pontesbury-field, which he presumes may expand to a great thickness in its passage beneath the new red sandstone of N. Shropshire and Cheshire.

*c. Coal fields in the Cleve Hills.*—These fields are thrown up to considerable heights above the adjoining country of old red sandstone, both in the Brown Cleve, and the Titterstone Cleve Hills, the coal being for the most part covered with basalt.

The Brown Cleve is distinguished by two tabular summits of black basalt (Jewstone), the highest of which is 1806 feet above the sea. The coal-bearing strata have for their base a hard sandstone occasionally conglomeritic, the equivalent of the millstone grit. On three sides of this ridge, these very thin and poor coal measures repose on old red sandstone, which to the west is a coarse conglomerate; but on the fourth or south-eastern side, there is interposed between the old red and the lower coal grits, a thin zone of limestone, which the author, therefore, refers to the age of the mountain limestone. Several faults are mentioned as traversing this coal tract from S.W. to N.E., one of which has been the source of eruption of much basaltic matter.

The Titterstone Cleve Hill is next described; and details are presented of those parts only which were unnoticed in Mr. R. Wright's

memoir. The most important of these relate to the Knowlbury field, which, from its juxta-position to the larger field of Coalbrook, the author terms a parasitic basin, and shows that it contains five seams of coal and some bands of ironstone. The strata around the verge of this basin are highly inclined, the dip diminishing as it approaches towards a common centre. Sections across this small basin exhibit considerable faults, which always occur as upcasts towards the higher sides of the hills, where the basaltic matter has found vent: coal, included between two of these upcasts, is described as much thickened and in the state of cannel coal.

Many fossil plants of new species from the Knowlbury and Gutter Works are described by Professor Lindley. Recent investigations of Mr. Lewis are mentioned, which prove the existence of a central dyke or funnel of basalt, thereby confirming the opinion formerly expressed by Mr. Bakewell; and a complete transverse section of these hills shows, that some beds of coal have been carried up on the top of the basalt, and that this rock has flowed laterally so as also to overlie the coal. Although these coal measures rest, in the greater part of their circumference, on the old red sandstone, the existence of an interpolated band of true mountain limestone is pointed out, which from the thickness of a few feet near Bennett's-end, extends to a maximum development of about 60 feet beneath one part of the Cornbrook field, where it contains subordinate beds of fine oolite, marl of various colours, abundance of characteristic organic remains, and is much contorted and dislocated.

At Orelton, near the north-eastern extremity of this range, and thus connecting it with the more eastern coal-fields, is a tortuous range of oolitic mountain limestone, which rests upon the old red sandstone and, exhibiting some extraordinary fractures and dislocations, passes beneath the unproductive or lower coal grits.

3. *Old red sandstone.*—In the vast formation comprehended under the term old red sandstone, the author includes all the red or green marls, conglomerates, sandstones, limestones, or flagstones, the youngest or highest beds of which pass immediately beneath the mountain limestone or carboniferous strata, and the lowest overlie and graduate into, the superior members of the grauwacke series. The author gives a geographical sketch of the western side of the great trough in which this formation is deposited in Shropshire, Herefordshire, and Brecknockshire; the prevailing strike of which is shown to be from N.E. to S.W., and the usual inclination to be to the S.E. The upper beds of the formation, near the Brown Clee, and partially near the Titterstone Clee Hills, expose a thin band of conglomerate; then follow, in descending order, red or green marls, with two or more zones of impure limestone called cornstone. To these succeed micaceous flagstones and thin-bedded building stones, with other strata of marls and cornstone. Massive varieties of concretionary limestone, termed ball-stones, range along the western foot of the Brown Clee. They are sometimes from 18 to 20 feet thick, and are very dissimilar in quality and in appearance from the

thin and conglomeritic bands of the rock. Alternations of red and green marls again succeed beneath the cornstones, and the base of the whole formation is usually marked, particularly in its course from Kington to Caermarthenshire, by highly micaceous greenish and reddish tile stones associated with marl. Thick-bedded, fine-grained building stones of excellent quality are worked near Hay in Herefordshire, overlying the tile stone division. No workable seam of coal has ever been discovered in the old red sandstone. Dr. Lloyd has recently discovered near Leominster and Ludlow, in the central and calcareous sandstone beds of the formation, fossils which are chiefly referrible to undescribed species of the family of Trilobites, and with them a few fragments of plants apparently terrestrial.

An expansion upon a large scale is pointed out in the old red sandstone, which, from a narrow tongue, is described as extending all over the forest of Mynydd Eppint, on the western side of which it reposes conformably and at high angles, upon the uppermost strata of grauwacke, at the chief escarpment of that rock. Many transverse sections from the grauwacke formations to the edge of the Glamorganshire coal-basin are given by the author, and they exhibit a perfect conformability between the upper beds of the old red and the lower members of the mountain limestone, as well as a gradual passage from the old red into the grauwacke. He, however, insists that there are no two formations of the English series which can be better separated from each other for purposes of geological illustration, than the old red sandstone and the uppermost grauwacke; the former being as poor as the latter is rich in organic remains, whilst the colours and mineral characters of the two formations are also very distinct. The maximum thickness of the formation is not easily defined with accuracy, but the author has no hesitation in saying that it exceeds 4000 feet.

In the latitudes of Llandovery and Llandilo, the whole formation is thrown so much on edge, that it necessarily occupies a very small superficial breadth, whilst the very slight inclination and the undulation of the beds in Herefordshire and Brecknockshire account for its vast expansion in these counties.

Detached tracts covered with this formation are pointed out as occurring far within the frontier of the grauwacke rocks; and they are considered to be true basins of elevation which have been formed on the western sides of certain anticlinal lines, along which the inferior sediments have a reversed dip.

April 17th.—Thomas Colbeck, Esq., Maddox-street, Regent-street, was elected a Fellow of this Society.

The second part of a memoir, commenced on the 27th of March, and entitled, "On the sedimentary deposits which occupy the western parts of Shropshire and Herefordshire, and are prolonged from N.E. to S.W., through Radnorshire, Brecknockshire, and Caermarthenshire, with descriptions of the accompanying rocks of intrusive or igneous characters," by Roderick Impey Murchison, Esq. F.G.S. F.R.S. &c., was read.

In this part of the memoir the author separates into distinct for-

mations by the evidences of fossils and the order of superposition, the upper portions of those vast sedimentary accumulations, which have hitherto been known only under the common terms of transition rocks, and grauwacke. Commencing at the base of the old red sandstone, which formation he had described in the previous part of the memoir, he proceeds to give an account of the underlying deposits as they succeed to each other in descending order in Shropshire and Herefordshire.

I. *Upper Ludlow Rock*.—Equivalent, Grauwacke Sandstone of Tortworth, &c.

This group, so named because the Castle of Ludlow stands upon it, is as eminently characterized by the presence of organic remains as the old red sandstone is by their deficiency. Amid a profusion of fossils, the upper beds are characterized throughout the whole range of the formation by two species of *Strophomena* or *Leptæna*, an *Orbicula*, a plicated *Terebratula*, &c. all of undescribed species. The middle beds contain many species of *Orthocera*; *Serpulæ*? of great size, &c.; and the lower strata are charged with a profusion of small *Terebratulæ* having a gryphoid form. Trilobites of the genera *Homonolotus* and *Calymene* occur. The group has a maximum thickness of about 1000 feet, is for the most part a thin-bedded sandstone, often highly calcareous, and at other times argillaceous, and in Shropshire frequently occupies distinct lofty ridges interposed conformably between the old red sandstone and the inferior limestone.

II. *Wenlock Limestone*.—Equivalents, Dudley Limestone, Transition Limestone, &c.

On the banks of the Severn near Wenlock, and in the Wenlock Edge, this group is particularly abundant in corals and *Encrinites*, nearly all the species of which, as well as of certain *Mollusca*, are found in the well-known limestone of Dudley. The exact position, therefore, which the latter occupies in the geological series of England, is thus for the first time determined.

The upper beds rising from beneath the Ludlow rock are thin-bedded and lenticular, and the lower beds in Wenlock Edge contain many concretions of very great size and of highly crystalline structure. Throughout its course in the district included between the rivers Oney and Lug, this limestone is chiefly characterized by the abundance of one species of *Pentamerus*, and at Aymestrey it is rich in that and other fossils\*. 100 feet are considered to be about the thickness of this calcareous zone.

III. *Lower Ludlow Rock*.—Equivalent, "Die Earth."

This group is chiefly made up of incoherent, greyish, argillaceous schist, seldom micaceous. The higher strata are in some places charged with many *Orthocera* of new and undescribed species, *Lituities*, *Asaphus caudatus*, &c. Other beds are locally distinguished

\* The author cannot allude to the fossils of this district without expressing his deep obligation to the Rev. T. Lewis of Aymestrey, whose unceasing researches have contributed very essentially towards the zoological illustration of this memoir.

by concretions of argillaceous limestone, formed around corals and other organic bodies; and towards the base of this deposit a thin calcareous zone is observable in Shropshire, containing the *Pentamerus lævis* and a new species of that bivalve, both differing from the species noted in the overlying group 2. The thickness is supposed to exceed 2000 feet.

The dislocations and faults on the Severn are described, by which this unproductive shale or "Die Earth" is brought in one point into unconformable contact with, and in another passes conformably beneath, the coal fields of Madeley and Brosely.

IV. *Shelly Sandstones*.—Equivalent, ————?

Red and green colours predominate in these sandstones, although purple and white are also frequently observed; by which characters, as well as by the nature of the stone and the specific differences in the organic remains, this formation is clearly distinguished from any of the overlying groups. Associated with the sandy strata are calcareous bands, almost made up of *Productæ*, *Leptenæ*, and *Spiriferi*, with crinoidal remains, all differing from those in the superior deposits. In Shropshire this formation rises at low angles from the valleys of lower Ludlow rock or Die Earth, and occupies separate ridges on the south-eastern flanks of the Wrekin and the Caer Caradoc. By a rough estimate 1500 to 1800 feet are assigned to the depth of the deposit.

V. "*Black Trilobite Flagstone*," &c.—Equivalent, ————?

The prevailing Trilobite in this formation is the large *Asaphus Buchii*, which with the other associated species is never seen in any of the overlying groups. In the mountain called the Longmynd, this flagstone is made up of black schists, hard and dark-coloured grauwacke sandstone, &c., in which Trilobites have not yet been observed, although they are abundantly characteristic of the same zone in its prolongation through Radnor, Brecknock, and Caermarthen shires, where these fossils occur in black limestone and calcareous flagstone and grit. The thickness of this formation probably exceeds that of any one of the superior groups.

VI. *Red Conglomerate, Sandstone, and Slaty Schist*.

This is a vast deposit of several thousand feet in thickness, consisting of very coarse, quartzose conglomerates, which alternate with some schistose beds and much purple-coloured sandstone (Compound Sandstone of Townson), the strata of which in Haughmond, Pulverbatch, and Linley Hills, Shropshire, are highly inclined or vertical, in conformity with those of the preceding formation. No organic remains have been observed, by which, and by its very peculiar mineral structure, this formation is shown to be entirely distinct from the preceding groups.

The above six deposits are all exhibited in Shropshire, trending from N.E. to S.W., and occupying distinct ridges and valleys. In their further prolongation to the S.W. the upper Ludlow rock is uniformly persistent. Strata lithologically similar and containing the same fossils are found invariably to rise from beneath the old red sandstone in the counties of Hereford, Radnor, Brecknock, and Caer-

marthen; sometimes at very low angles of inclination, while at others, as in the promontories near Ludlow and Brecon, they are thrown up into saddles, and at the south-western limit of Brecknock and Caermarthen shires they are vertical or very highly inclined.

The second deposit, or Wenlock (Dudley) limestone, thins out a little to the S.W. of Aymestrey, and the groups 1 and 3 being brought together, generally occupy the same lofty escarpment in their course through S. Wales. Hence the author suggests the term Ludlow formation (the upper and lower Ludlow rock being subordinate members), as applicable to all the higher portion of this series which has a tripartite character in Salop and Hereford, due to the interpolation of the Wenlock and Aymestrey limestone.

The deposits 4, 5, and 6, are three separate formations, entirely differing from each other, and from the Ludlow formation, in their characters, mineral and fossil, and in the distinctness of their physical demarcations. They are not, however, to be traced continuously in their course from Shropshire on the N.E. to Caermarthen-shire on the S.W.; though they reappear at intervals on that strike, preserving their relative places in the geological series.

In those districts where parallel ridges of all these formations are brought to day within a zone of small breadth, rocks of trappean or igneous origin are usual accompaniments, as in the neighbourhoods of the Wrekin and Caer Caradoc, in Shropshire; and again, after a long interval, in the environs of Old Radnor, Builth and Llandeugly. In the intervening and featureless tracts of Clun, Knuckless and Radnor forests, where such intrusive rocks are absent, the Ludlow formation alone is spread out in undulating masses, and upon its surface are frequently found detached and elevated basins of old red sandstone.

The heights of the different groups above the sea-level vary from 500 to 2000 feet.

The author reserves for the third part of his memoir, which he proposes to communicate on a future occasion, the description of the numerous trappean and porphyritic rocks, which, in penetrating through these grauwacke deposits, have produced changes in their mineral aspect and structure. On that occasion the question of the parallelism of these sedimentary groups will be reviewed in reference to the direction of the outbursts of rocks of igneous origin. The quartz rock on the flanks of the Wrekin and Caer Caradoc, and also in the singular ridge of the Stiper Stones, will be described under the head of "Altered Rocks." The relations of the formations on the eastern side of Herefordshire will also be explained, with the view of determining whether deposits of the same age and character rise from beneath the old red sandstone in the flanks of the Malvern Hills, &c., as have been shown to exist on the opposite or western side of the great field of old red sandstone.

May 1.—Robert Scarlett, Esq., of Park Street, Westminster; Rev. R. W. Browne, B.A., Fellow of St. John's College, Oxford; George Silvertop, Esq., of Minster Acres, Northumberland; Andrew Martin, Esq., of Suffolk Place, Pall Mall East; Henry Dar-

win Rogers, Esq., of Philadelphia; and John Lewis Prevost, Esq., His Majesty's Consul-general for Switzerland, of Suffolk Place, Pall Mall East; were elected Fellows of this Society.

A paper was first read, entitled, "Notice of a Machine for regulating high temperatures, invented by the late Sir James Hall, Bart., F.G.S.," and drawn up by Captain Basil Hall, R.N., F.G.S. &c.

Sir James Hall, in his experiments on the fusion of granite and other rocks, and on the effects subsequently produced upon the fused mass by gradual cooling, conceived that the experimenter required the power of regulating the temperature in such a manner as best to imitate nature; and for this purpose he invented the machine described by Captain Basil Hall.

The principle of the machine is such, that when any change of temperature takes place in that part of the furnace in which the material under experiment is placed, a corresponding change is made in the current of air which maintains the heat.

The furnace was about 3 feet long, 18 inches wide, and  $2\frac{1}{2}$  feet deep. From side to side extended a muffle, one end of which was closed with a plug, furnished with a small disk of mica, through which the subject of the experiment could be viewed; and at the opposite end of the muffle was placed the machine.

This instrument consists of a spiral spring coiled in a vertical plane, and facing the muffle. The spring is formed on the principle of Harrison's balance in chronometers, of two metals joined together, but of different degrees of expansibility, so that the spring will either curl or uncurl, according as the heat is raised or depressed. The outer part of the coil is fixed, while the inner end is united to an axle, which, being free, turns round as the spiral winds or unwinds; or as the heat, radiating from the interior of the muffle, is raised or depressed.

To the further end of the axle is bitted a wheel, around the circumference of which is wound a string, carrying at its extremity a small weight, which consequently rises or falls as the spiral curls or uncurls. Under the weight is a little cup, forming one end of a lever, to the opposite end of which a metal disk is suspended, immediately over an aperture of rather smaller dimensions, and near the end of a long iron channel, through which alone air was supplied to the furnace. Directly under this aperture is another of similar size, as well as another disk united to the upper disk by a rod of metal, equal in length to the distance between the two openings. The object of having two apertures is to secure the same amount of current of air both above and below. If there were only one opening, and one disk to close it, the air rushing in would force it down and keep it closed; but by this contrivance the rush of air at the lower opening striking on the under surface of the lower disk, exactly counterbalances that from above which strikes upon the upper surface of the superior disk. To render the points of contact perfect, and to prevent the interference of small particles of dirt, the disks, when closed, rest upon circular knife-edges.

Besides the wheel, around which the cord carrying the small

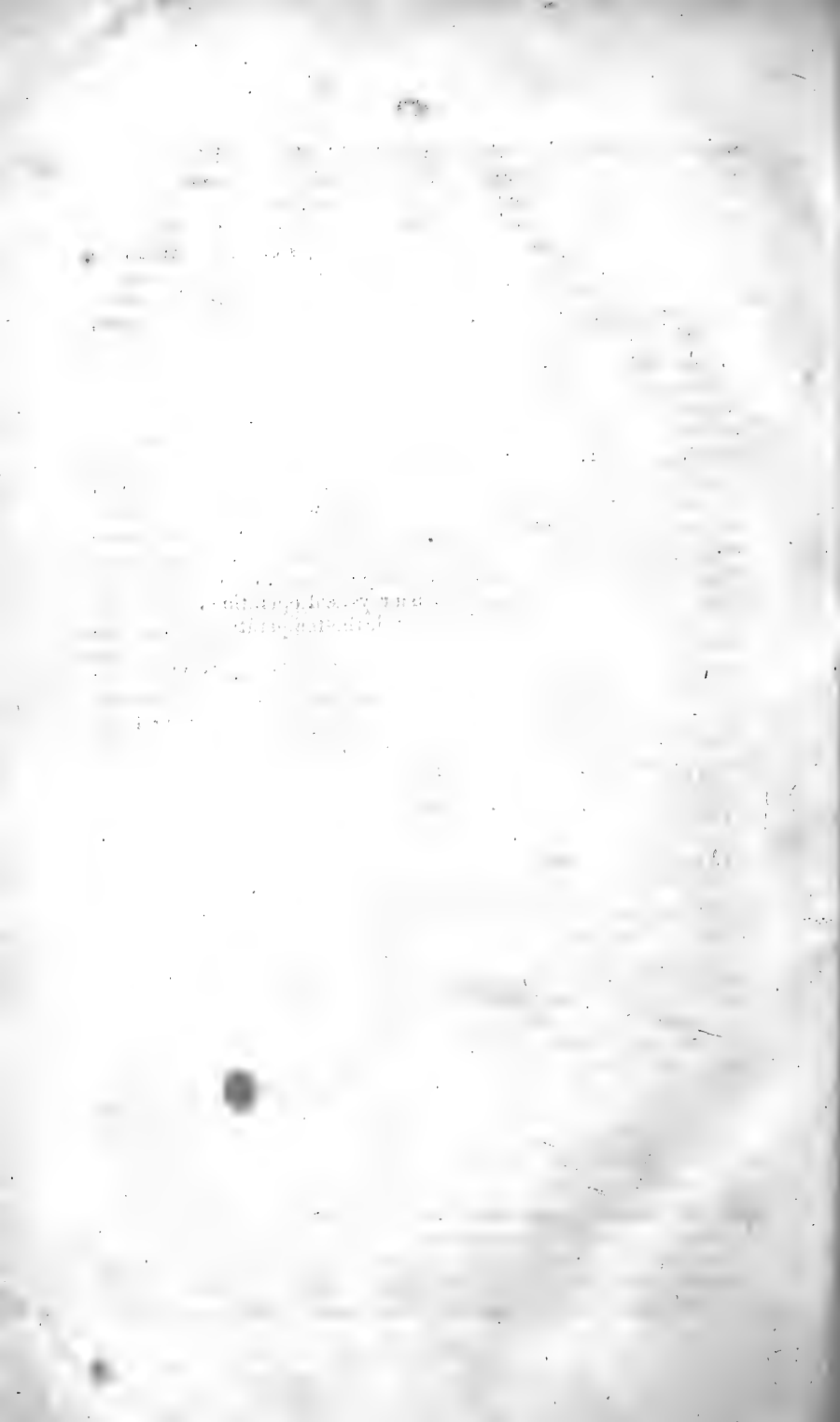


weight is wound, the axle connected with the spiral is furnished with a long hand, like that of a clock, reaching to a large graduated circle in the same plane with the first wheel, but lying beyond it. This hand is capable of being attached to the wheel carrying the weight, and consequently of indicating changes of temperature with great rapidity.

To preserve uniformity of temperature, the spiral, and as much of the apparatus as possible, were inclosed in a tin case, filled with water kept constantly boiling; so that the only change to which the spiral was subjected, was the heat radiating from the muffle.

The action of the instrument is simply this. The heat of the furnace having been raised to the required pitch, a change in the radiant heat from the muffle effects a change in the action of the spiral, and the string supporting the weight is consequently either lengthened or shortened. If the change in the radiant heat be an increase, then the string is shortened, the weight is removed from the cup at one end of the lever, and the disks at the other end consequently falling, the current of air is checked, and the heat within the furnace is checked also. If, on the contrary, the change in the radiant heat be a diminution, then a reversed operation takes place, and the current of air being increased, the temperature of the furnace is also increased.

A letter was afterwards read from Mr. Telfair to Sir Alexander Johnstone, V.P.R.A.S., accompanying a specimen of recent conglomerate rock, from the Island of Madagascar, containing fragments of a tusk, and part of a molar tooth of a hippopotamus; and communicated by Roderick Impey Murchison, Esq. F.G.S.



# PROCEEDINGS

## OF

### THE GEOLOGICAL SOCIETY OF LONDON.

1833.

No. 32.

May 15.—George Wareing Ormerod, Esq., B.A., of Brasenose College, Oxford, and of Ardwick, Lancashire; Viscount Borringdon, of Kent House, Knightsbridge; James Garth Marshall, Esq., Headingley near Leeds; Samuel Chartres, Esq., Capt. Royal Artillery, Bath; Damiano Flores, Esq., Commissioner of the Bolaños and Vetu Grande Mines in Mexico; and Joseph Prestwich, jun. Esq., of the Lawn, South Lambeth, were elected Fellows of this Society.

A paper was first read entitled “Observations on the Cliffs in the Neighbourhood of Harwich, made in December 1832,” by James Mitchell, Esq., LL.D., F.G.S.

The principal object of this paper is to give a detailed description of the beds of London clay, as they appeared in the Harwich cliffs at the time the author visited the spot. After pointing out the physical features of the line of coast, the effects which the sea has produced upon the cliffs, and the means which have been taken to defend them, he proceeds to give an enumeration of the beds presented in a cliff which begins about 300 yards to the south of the lighthouse, and extends for rather more than a mile. The greatest height of the cliff is stated to be 35 feet, and the escarpment, where examined by the author, to present the following details:—

Vegetable soil .....	
Clay containing numerous chalk flints and rolled pebbles.....	1 foot.
Red clay separated into beds by whitish or greenish streaks, about .....	20 feet.
Cement marl or indurated marl, two strata separated by a bed of clay .....	2 —
Cement stone .....	10 inches.
Blue clay divided into two beds by a whitish streak, about .....	7 feet,

The lines of stratification are stated to be not horizontal at this point, but to have a gentle anticlinal dip.

In the prolongation of the cliff to the south, the face of the escarpment is said to be divided into only four thick horizontal beds.

Two strata of the cement stone are stated to occur in the neigh-

bourhood of Harwich, separated from each other by about 20 feet of clay : and the author mentions that in sinking wells in the town, the chalk has been found at the depth of sixty feet.

Iron pyrites, occur in great abundance at the foot of the cliffs, and lignite, but sparingly. Fossils are said to be procured chiefly from the cement stone, and a species of *Venus* to be the most abundant.

The author next gives a description of the cement stone; the history of its first discovery by the late Rev. Dr. Parker in the year 1796; a list of the localities where it is found in the greatest abundance; then points out the difference between the cement stone of Harwich and Sheppey, and lastly, advances an opinion on the probable period at which the supply will fail.

"A Memoir on the Valley of the River Medway and the adjacent Country," by R. Dadd, Esq., and communicated by James Mitchell, Esq., F.G.S., was then read.

The country described by the author lies in the immediate vicinity of Chatham and Rochester, and is characterized by the passage of the river Medway through a narrow, winding gorge bounded by chalk hills. It exhibits six different deposits, viz.—

1. Lower chalk.
2. Upper chalk.
3. Plastic clay.
4. London clay.
5. Diluvium.
6. Alluvium.

1. On the right bank of the Medway the lower chalk is very little exposed, appearing principally at Burham, where it is extensively quarried, in the form of low downs covered in many places by diluvium. On the left bank it is much more extensive, forming higher and bolder hills, and reaching from the entrance of the gorge to Whornes Place, with a breadth varying from a mile to half a mile. Its fossils are abundant, but not various, being chiefly *Ammonites*, *Terebratulæ*, *Inocerami*, *Pectens*, and remains of Fishes and Saurians.

2. The upper or flinty chalk is extensive on both sides of the river, forms most of the high land of the district, and is the basis on which the newer deposits rest. Into these strata all the deep wells penetrate. In its mineralogical and fossil characters it is similar to the upper chalk beds of other localities. Its surface is hollowed and uneven, and is often covered, even at considerable elevations, with patches of diluvial matter.

3. The plastic clay and its accompanying sands appear, at a former period, to have extended over the whole district; for their remains are found in every valley, and on every hill patches of it remain undisturbed by the phenomena which attended their elevation. This formation extends from Cuxton valley through Strood to Frindsbury Hill; as also from Whitewall Creek over and behind Barrow Hill, through Upnor, along the banks of the river to near Cockham Wood Fort. An instructive section has been formed

at the latter locality by the operations of the workmen in digging brick earth. Fossils, chiefly belonging to the genera *Ostrea*, *Cyclas*, and *Cerithium*, occur most in one particular part of the deposit called the clay and shell bed: it consists of a bluish black, tenacious clay alternating with shells which are tender and chalky.

4. The London clay is of very small extent in the district described by the author, but possesses the same characters as at Shooter's Hill. It merely caps the hill below Upnor, and extends to Hoo, with a breadth of less than  $\frac{1}{4}$  of a mile, and a length of  $2\frac{1}{2}$  miles.

5. The diluvium is met with on the slopes and tops of the hills, as well as in the valleys. In the latter its average thickness is 6 feet, but in some situations it considerably exceeds 20 feet. On the former it varies from 1 foot to 20 feet in thickness, with an average of 2 feet. In situations not exposed to the action of running water, as on the summits of the hills, it consists in the lower part of water-worn chalk, mingled with displaced but unrolled flints, which are often so friable as to fall to pieces when moved. Above these lies a mixture of stiff red clay and flints, with occasional seams of sand. The fossil remains discovered in this deposit are the bones and teeth of the Elephant, Deer, Rhinoceros, and of an unknown animal.

6. The alluvial matter deposited by the present stream consists of gravel and rolled pebbles, covered by dark blue clay and vegetable remains, having a depth of ten feet or upwards. Its extent on both sides of the river proves that the Medway formerly occupied a much greater breadth than at present; and the large marshes below Chatham attest its tendency to accumulate. In fact, the river is said to have perceptibly shallowed within the last forty years.

A memoir was afterwards read "On a Fossil in the Bristol Museum, and discovered in the Lias at Lyme Regis," by Dr. Riley, and communicated by Charles Stokes, Esq., F.G.S., &c.

After stating the different opinions which had been given by those naturalists who had seen the specimen, and alluding to their apparent incorrectness, the author states that he is induced to consider the fossil as the remains of a cartilaginous fish, having many points of resemblance to the Rays, but differing from them in several important characters. He then proceeds to give a minute description of the anatomical structure of the fossil, commencing with the head. He states that the jaws are very much elongated; that he could discover in the upper no traces of respiratory canals or openings; that it appears to have fitted into a central groove in the lower jaw; that there are no signs of any cavities for the reception of teeth; but that there are lying near the jaws many spines with radiate bases similar to the spines of rays and other cartilaginous fishes. The orbits are stated to be of immense size, surrounded by an elevated edge or ridge, and the space on each side of the median line and within these ridges and corresponding to the parietal and frontal bones, to be flat and depressed not unlike that of a Saurian; but the author considers

that this depression between the orbits may be better accounted for by the fact of this part of the cranium being nothing more than a thin membrane, as in some of the Chondropterygii.

The vertebral column is said to be less injured than the other parts of the animal. The processes have disappeared, but the bodies of the vertebræ are perfect; they are circular and very numerous, amounting to about 260, 28 of which are cervical, 143 dorsal, and 90 caudal. From the slight groove for the reception of the spinal marrow, and the separated condition of the cervical vertebræ, the author is inclined to consider the spine as having a nearer resemblance to that of a *Squalus* than of any other of the cartilaginous fishes.

The thoracic and pelvic members are stated to be greatly injured; but from the characters which they present, it is inferred, that they afford additional proofs that the fossil belonged to a cartilaginous fish.

In conclusion, the author conceives himself justified in considering the specimen as the type of a new genus, and therefore assigns to it the appellation of *Squalo-raia Dolichognathos*.

May 29th.—Richard Grantham, Esq., of Limerick, and James Hardie, Esq., of the Bengal Medical Establishment, F.A.S. Cal., were elected Fellows.

A paper "On the Oolitic Formation and its Contents, as occurring in a Quarry at Bearfield, near Bradford, Wilts," by J. Channing Pearce, Esq., F.G.S., was first read.

The principal object of the author is to describe the organic remains which he found in a quarry situated at the summit of the hill to the north-west of the town of Bradford in Wilts, and in the same range of hills with that called Farleigh Down, near Bath. The following is a section of the beds, in descending order:—

	Ft.	In.
A. Clay above the oolite .....	10	0
B. Debris of shells, &c. ....	0	6
C. Firestone .....	15	0
D. Rag .....	30	0
E. Yellow clay .....	1	0
F. Soft freestone .....	12	0
G. Rubbly freestone .....		

The organic remains are found principally in two of the strata, namely, in the shelly bed B, which lies directly on the surface of the great oolite (C. &c.), and in the yellow clay, marked E, which lies within the oolite. The fossils of the bed B, are *Aviculæ* in abundance, numerous species of *Terebratulæ* and *Ostreæ*, with several other species of univalve and bivalve shells, Corals, *Asteriæ*, *Echini*, vertebræ and teeth of fishes, Crustaceæ, *Pentacrinus vulgaris*, *Eugeniocrinites pyriformis* (Goldfuss), and three species of *Apio-crinites*, viz. *Apio-crinites globosus*, *A. intermedius*, and *A. elongatus*. The author observes that where the undulations of the great oolite rise above the level of half a foot, the debris of shells are wanting.

He also remarks that the columns of the *Apiocrinites* are never found erect, but appear to have been thrown into their present, horizontal position by the superincumbent weight of clay at the moment of deposition. He supports this opinion by the fact that the columns, though in general separated from the roots, have their terminations almost invariably directed towards them,—an arrangement which he believes could not have occurred, had they been broken off and swept from their pedicles by a strong current.

The fossils contained in the yellow clay bed E, are *Terebratulæ*, *Ostreæ*, *Echini*, palatal bones, numerous small corals, and the three species of *Apiocrinites* already mentioned. The remains of the latter are abundant, but in this bed, as in the stratum B, the *Apiocrinites elongatus* is the most rare.

The author next proceeds to draw the distinctive characters of the genus *Apiocrinites*, and afterwards those of the three species above enumerated. The memoir was illustrated by drawings and very fine specimens of the fossils.

“A paper upon some tertiary deposits in the province of Granada, and part of that of Sevilla, and along the line of coast from Malaga to Cartagena, in the South of Spain,” by Col. Charles Silvertop, F.G.S., was then read.

The province of Granada is bounded on the south by the Mediterranean and on the north by the Sierra Morena, embracing a district of about 120 miles in breadth. The distance from Malaga to Cartagena is equal to about 250 English miles. Parallel to the Mediterranean and not far distant from its shores, the district is traversed by a ridge of mountains to which the author applies the name of the Sierra Nevada, though this appellation refers properly only to the highest portion of the chain.

After briefly alluding to the primary and transition formations which constitute the central ridge of the Sierras, to the secondary sandstone and limestone on their flanks, and to the igneous or trappean rocks which appear in various parts of the country examined, the author enters into a minute description of the tertiary formations. These deposits he divides into two distinct districts, one bordering the shore of the Mediterranean and situated between it and the southern foot of the Sierra Nevada, and the other occupying portions of the district, between this chain of mountains and the southern base of the Sierra Morena.

The tertiary beds ranging along the coast from Malaga to Cartagena, with occasional interruptions, are stated to consist of clay, sand, coarse sandstone, conglomerate, sandy loam and marl, and friable limestone, containing various shells and corals. In the neighbourhood of Malaga they are divided into two groups distinguished by their fossil contents, and stated, on the authority of M. Deshayes, to belong to the Pliocene period of Mr. Lyell.

The relative heights at which the beds occur are said to differ considerably, being in some places almost on a level with the shore, but at others at nearly 1000 feet above it. This difference the author conceives may have been produced by the protrusion of the

volcanic rocks, which abound near the locality where the elevation is greatest.

The tertiary formations between the Sierra Nevada and the Sierra Morena, are divided into three districts, called by the author after the names of the principal towns situated in them, viz., Alhama, Antequera, and Alcala la Real. The principal strata are composed of calcareous sandstone and friable limestone, containing numerous fragments of corals and shells. The fossils are stated to differ from those found in the deposits along the shore of the Mediterranean, and to be characteristic of the middle or Miocene period of Mr. Lyell. The strata are described as occupying very different levels, varying from 1000 to 1500 feet above the sea, and as being occasionally inclined at considerable angles.

Besides these three principal deposits, several others of minor extent and situated in the province of Sevilla are noticed; and in concluding his paper, the author alludes to the proofs afforded by these widely scattered remnants of tertiary formations, of the great extent of an ancient sea in this southern portion of the Peninsula, and of the violent manner in which the deposits have been acted upon by igneous and aqueous agents.

June 12.—Stephen Woolryche, Esq., Inspector General of Hospitals, Heath Farm, Cashiobury, Hertfordshire; Rev. Edward Denison, Fellow of Merton College, Oxford; Philip Pusey, Esq., of Pusey, near Faringdon; Richard Westmacott, jun., Esq., of Wilton Place; and Abel Lewis Gower, Esq., of Finsbury Square, were elected Fellows of this Society.

A paper entitled "A Notice on some Specimens from the Coal Shale of Kulkeagh, and the subjacent Limestone in the County of Fermanagh," by Sir Philip de Malpas Grey Egerton, Bart., F.G.S., was first read.

After alluding, in terms of commendation, to Mr. Griffith's account of the Connaught coal-field, the author states that his principal object is to describe the organic remains which he obtained, in conjunction with Lord Cole, from the beds of shale forming part of the lowest division of the coal series. This shale deposit is stated to be 600 feet thick; to be covered by 70 feet of sandstone, and to be separated, in the northern division of the district, from the subjacent or mountain limestone by another system of sandstone strata about 40 feet thick. It is described as being composed principally of frequent alternations of beds of shale, more or less indurated, and of clay-ironstone. In the upper part of the series, several beds of black argillaceous limestone and a thin stratum of micaceous sandstone are stated to occur, and in the lower a bed of finely grained ferruginous sandstone. The shale is said to differ considerably in aspect, colour and structure at the superior and inferior portions of the deposit, but that the distinctive characters pass into each other by insensible gradations. The whole of the beds are stated to be replete with organic remains, entirely different from those found in the subjacent limestone. In the upper strata the prevailing fossils enumerated in the Memoir, are Ammonites and Orthocerata, associated,



though in less abundance, with *Producta* and *Calamites*; and in the lower, crinoidal remains and corals of the genus *Calamopora*.

The author then describes the subjacent sandstone; the phenomena which accompany the streams engulfed by the mountain limestone, and the fossils he procured from that formation; and lastly, he details the characters of a bed of shale which occurs at the bottom of the limestone system, and abounds with fossils, some of which are stated to be peculiar to it.

A paper "on the Osseous Cave of Santo Ciro, about two miles to the S.E. of Palermo," by Samuel Peace Pratt, Esq., F.G.S., F.L.S., was then read\*.

The author first describes the circumstances which led to the discovery of the bones, and then the position of the cave and the phenomena it presents. He states that it is situated rather more than a mile from the sea, in a projecting hill, forming part of the ridge of secondary limestone, which nearly traverses the northern portion of Sicily, and about 50 feet above the foot of the promontory. A gently inclined plain extends from the base of the ridge to the shore, and is composed of nearly horizontal strata of limestone and sand, containing shells analogous to those now inhabiting the Mediterranean. When discovered, the cave was filled to the level of the entrance with bones, more or less rolled, and in different states of decay, but cemented together by carbonate of lime. Associated with them, though in much less quantity, were pebbles and fragments of limestone. The bones which have been found, belong principally to the Hippopotamus; but tusks and teeth of the Elephant, as well as teeth of a large carnivorous animal, have been discovered. An osseous breccia extends around the mouth of the cave to the distance of many yards but differs from that within, in the greater abundance of fragments of limestone and pebbles, and in the bones having undergone greater attrition. The cave has been excavated to the depth of 20 feet, and its irregular sides appear to have been worn by water into polished hollows, perforated by the *Lithodomus*. Marks of the action of water, though to less extent, are visible much higher than the mouth of the cave, but the labours of the *Lithodomus* appear to have been confined to the surface below its level. The bottom of the cave was found to be covered with comminuted shells mixed with numerous well preserved specimens. Four other caves are mentioned as occurring at higher levels in the face of the hill. No bones have been discovered in them, though they bear the same proofs of the action of water, and their walls are perforated in the same manner. In conclusion, the author infers, from the evidence presented by the caves, and the known habits of the *Lithodomus*, that this part of the coast of Sicily was successively elevated to its present level, subsequently to the Mediterranean being inhabited by the existing species of *Testacea*, and he speculates on the changes which may

\* When the author of this paper made his observations, he was not aware of the Memoir on Sicily by Dr. Turnbull Christie, read before the Society in November 1831. See p. 333.

have been produced at the same time in the physical outline of the country.

A communication from Capt. Colquhoun, and addressed to Roderick Impey Murchison, Esq., F.G.S., descriptive of masses of meteoric iron found in Mexico and Potosi, was next read.

The mass of iron principally noticed in this communication was formerly in the street of San Domingo, at Zacatecas in Mexico. It was about  $4\frac{1}{2}$  feet long and  $1\frac{1}{2}$  broad. On one side it was marked with deep indentations. The other masses were found at Charcas and Pablazon near Catorce.

A letter was lastly read, from Mr. Gardner, Geographer, to Roderick Impey Murchison, Esq., F.G.S., "On the relative position of land and water with respect to the Antipodes."

This letter was accompanied by a map of the world, on which was delineated, by colours, the antipodes of the existing dry land: and the writer of it states that he had ascertained by measurement that only  $\frac{1}{27}$  part of the present continents and islands has land opposite to it; that the antipodes of the eastern hemisphere are confined to South America, with the exception of about the  $\frac{1}{800}$  part, situated principally in New Zealand; and that the reciprocal antipodes of the western hemisphere fall on part of China and the Eastern Archipelago.

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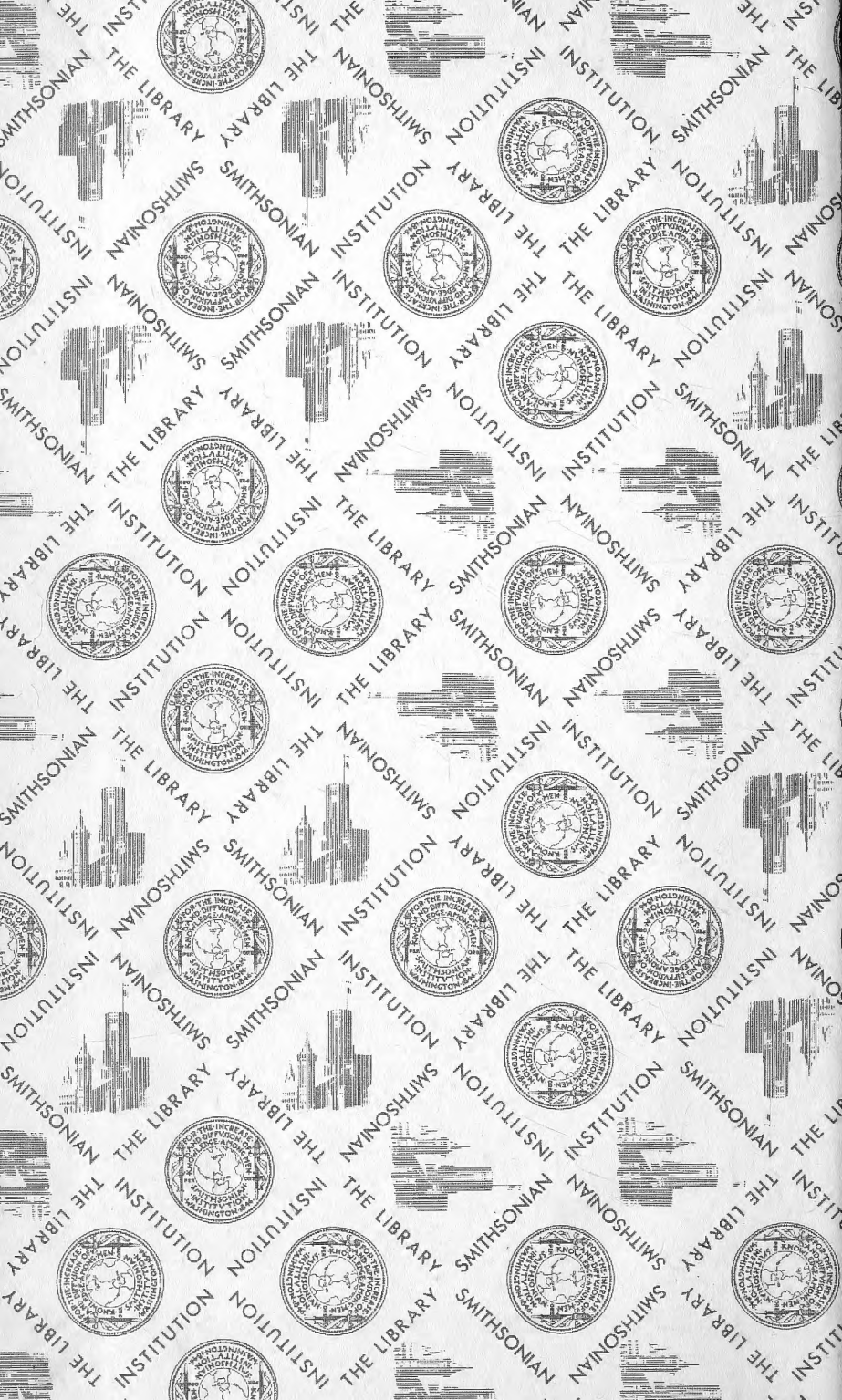


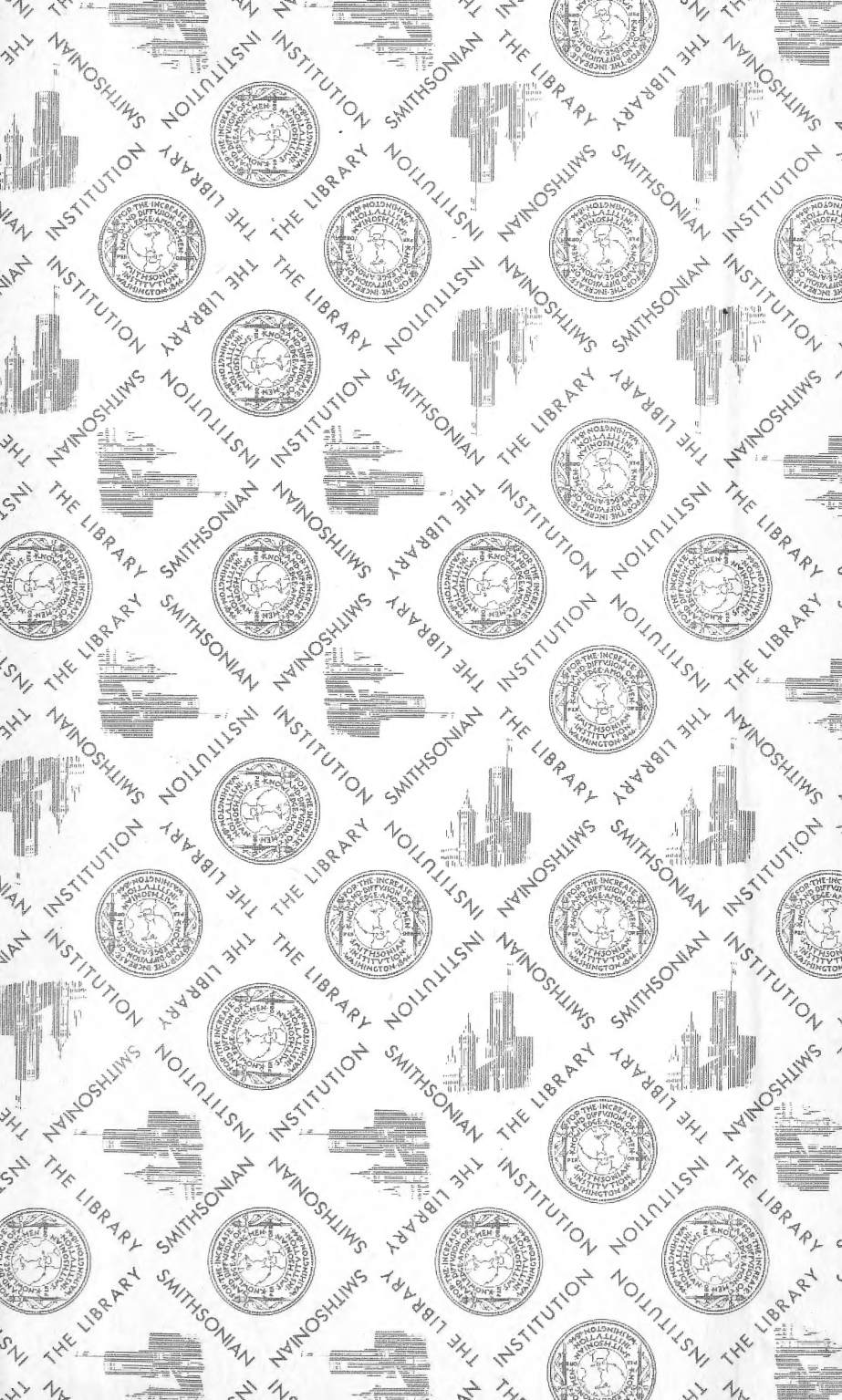












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